Selection and use of instructional videos by secondary teachers: knowledge and context

Matthew Edward Brick Fyfield

BA, Grad Dip (Sec), Grad Cert (Ed Research)

A thesis submitted for the degree of *Doctor of Philosophy* at
Monash University in 2020
Faculty of Education

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Abstract

Instructional videos are an increasingly ubiquitous part of secondary education due in no small part to the rise of online streaming platforms such as YouTube. This study sought to understand how teachers in mainstream, face-to-face secondary schools select and use instructional videos and the role of teacher knowledge and context in this process. The literature review revealed that while the research base on instructional video design and use was well established, primarily in the fields of Cognitive Load Theory (CLT) (Sweller et al., 1998) and the related Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2014b), much of this literature proposed best practices or investigated atypical video-based pedagogies in specialised contexts excluding many of the contextual realities of classroom teaching.

In contrast, this study sought to explore the range of knowledge types teachers use when selecting and using instructional videos in ordinary classroom contexts. In analysing this knowledge, this study draws on the framework for teacher knowledge advocated by Shulman (1986, 1987), and Mishra and Koehler's (2006) technological, pedagogical and content knowledge (TPACK) framework. Teacher knowledge is always enacted in particular contexts and this study drew on the contextual framework proposed by Porras-Hernández and Salinas-Amescua (2013) and extended by Rosenberg and Koehler (2015a). This framework separates contextual factors into micro, meso, and macro and examines the ways in which these factors motivate, constrain, or shape teacher actions.

This research was driven by a single research question, with two subsequent questions acting as boundaries to the study:

RQ: How do teachers select and use instructional videos?

SQ1: What role does teacher knowledge play in the selection and use of instructional videos?

SQ2: What role does context play in the selection and use of instructional videos?

In addressing this question, a multiple case study methodology was applied to the selection and use of instructional videos of nine teachers working in two mainstream secondary schools in Melbourne, Australia.

The analysis supports four findings concerning the ways teachers use their knowledge to select and use instructional videos: (1) Wisdom of practice is the key source teachers draw on when developing knowledge about instructional video use; (2) Pedagogical content knowledge, knowledge of learners, content knowledge, and curricular knowledge contribute to effective selection and use of instructional videos, while technological knowledge is less important; (3) Curricular knowledge exists in a hierarchy, determining content and facilitating selection of videos; and (4) Teacher knowledge both empowers and bounds teacher practice.

The analysis also supports six findings concerning the impact of context on instructional video selection and use: (1) Teachers select and use videos in isolation; (2) Teachers' perception of being time-poor impairs their ability to enact their knowledge of best practice video selection and use; (3) In order to maintain control and contextualise content, teachers tend towards using communal projectors to displays videos; (4) YouTube is the dominant source of instructional videos used in mainstream classrooms; (5) Teachers often use uncritical search techniques to find videos on YouTube thus allowing the algorithm to influence their choices; and (6) Algorithmic platforms like YouTube are falsely transparent technologies. The thesis outlines five implications for professional practice and teacher training, along with seven avenues for future research.

Publications during enrolment

Fyfield, M., Henderson, M., & Phillips, M. (2020). Navigating four billion videos: teacher search strategies and the YouTube algorithm. *Learning, media and technology*, 1-13. https://doi.org/10.1080/17439884.2020.1781890

Fyfield, M. (2020). YouTube in the classroom: How teachers use instructional videos in mainstream secondary classrooms. *Technology, Pedagogy and Education*. (in press)

Fyfield, M. (2020). *Human-Software Entanglement and YouTube: Algorithms Mediate the Practices of Teachers and Producers.* Annual Conference of the American Educational Research Association, San Francisco (Online). http://tinyurl.com/rqy4wos

Fyfield, M., Henderson, M., Heinrich, E., & Redmond, P. (2019). Videos in higher education: Making the most of a good thing. *Australasian Journal of Educational Technology, 35*(5), 1-7.

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List of Abbreviations

Acronym	**Meaning**
CLT	*Cognitive load theory*
CTML	*Cognitive theory of learning from multimedia*
DVD	*Digital video disk*
ICALM	*Integrated cognitive affective model of learning from multimedia*
PCK	*Pedagogical content knowledge*
PK	*Pedagogical knowledge*
PR&A	*Pedagogical reasoning and action*
STEM	*Science, Technology, Engineering and Mathematics*
TK	*Technological knowledge*
TPACK	*Technological, pedagogical and content knowledge*
TPK	*Technological and pedagogical knowledge*
VCAA	*Victorian Curriculum and Reporting Authority*
VCE	*Victorian Certificate of Education*
VHS	*Video Home System*

Declaration

This thesis is an original work of my research and contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signature: …………………………………………………..…

Print Name: Matthew Edward Brick Fyfield

Date:

Acknowledgements

This thesis would have been impossible without the generous support of the nine educators who gave of their time, expertise, vulnerability and enthusiasm, and the gracious principals who allowed a student researcher to invade their schools.

My dear supervisors, friends, support staff, cheer squad, and mentors: Associate Professor Michael Phillips and Professor Michael Henderson. I scour my memory and fail to find a time I could have asked for any more than you gave. Particularly in this final year, one that will be recorded in history as one of isolation, I felt nothing but known and encouraged, appreciated and guided. You gently tamed my initial harebrained ideas. You allowed me to make mistakes, to pursue fruitless avenues, and to craft and recraft my work. You read my endless drafts and ensured that despite your careful guidance, this remained my thesis. I have received a thorough academic apprenticeship and emerge a more grounded person. Thankyou.

To my precious daughters Veronica, who was born right at the start of this process, and Bethany, born a week before the completion of a full draft. You have given of your daddy, who was too often locked away in the office, or whose mind wandered when he should have been concentrating on you. You were also a constant reminder of why improving education matters. Thankyou.

The greatest acknowledgement goes, of course, to the hidden hero of this work. My wife, my best friend, my unwavering champion. Bec, not a single idea in this thesis hit the page without first being tried out on you. Not a day went past without you encouraging me, refining my ideas, and being my resident working teacher on whom I tested my ideas of the state-of-the-actual. I cannot, and shall not, try to put into words how much of this belongs to you.

Dedication

I dedicate this thesis to my educational forebears.

My Grandfather John Fyfield: teacher, principal, and Professor of Education at Monash University, who in his dying days was still reading, still seeking new knowledge. Ancora Imparo. You instilled a deep respect for scholarship, precision, and educational integrity.

And to the greatest educators I have had the privilege to study under:

My dear late father, Paul Brick, who taught me that learning was a process to love, not endure. You would have read this thesis in a matter of hours, understood it all, and offered me an entirely different analysis. It would undoubtedly have been better.

Finally, my mother, Sally Fyfield. The hardest working educator ever to grace a classroom. Generations of children are the beneficiaries of your dedication and expertise, but none more so than my siblings and I. May your example remind us all that no algorithmic platform could ever replace the humanity of a masterful teacher.

Chapter 1: Introduction

The use of instructional videos in education is growing (Poquet et al., 2018). This is true both of content produced specifically for education and that created for other purposes, such as entertainment, that is repurposed and used in educational settings (Cunningham et al., 2016). The number of videos available to teachers is also rapidly expanding, due in no small part to the rise of user generated video streaming platforms. YouTube alone hosts over 4 billion videos (Bärtl, 2018), and according to its own marketing material, learning related videos on YouTube are watched over a billion times a day (YouTube, 2019). Ostensibly, instructional video resources are plentiful and easily accessible.

If to the untrained observer teaching at times appears to be an easy activity (Loughran et al., 2016), finding a relevant YouTube video and pressing play may appear even more so. But teaching is not easy. It has been described as "complex and dilemma laden" (Loughran et al., 2016, p. 388), "messy and unpredictable" (Eisner, 2002, p. 378), and "perhaps the most complex, most challenging, and most demanding and frightening activity our species has ever invented" (Shulman, 2004, p. 504). Effective teaching using instructional videos may be just as complex and requiring of expert knowledge. Despite this, teaching with videos in the context of mainstream secondary classrooms and the knowledge teachers use to do so remains remarkably underexplored in the literature.

1.1 Statement of research problem

While there is a growing body of literature explaining and critically analysing video-based learning approaches like flipped classrooms (Chen et al., 2015; Gross et al., 2015; Lo & Hew, 2017; Zara et al., 2019) and massive online open courses (MOOCs) (Kim et al., 2014;

Koedinger et al., 2015; Oakley & Sejnowski, 2019; Yousef et al., 2014), there is little research dealing with the selection and use of instructional videos in mainstream secondary classrooms. The term mainstream is used to indicate the most common type of education in Australia, meaning mass compulsory face-to-face schooling (Selwyn, 2014). In such settings the literature remains silent about questions concerning the types of videos secondary teachers select, where teachers search for these videos, and how they are used in teaching practice. These questions are important both in terms of theory and practice.

At a theoretical level, while teacher knowledge has been examined in detail with regard to the use of technologies in general (see Section 2.1.7), no work has been done exploring whether existing models of teacher knowledge apply to the selection and use of instructional videos. In particular, this study applies existing models of teacher technological knowledge, such as Mishra and Koehler's (2006) technological and pedagogical content knowledge (TPACK), to the ways in which teachers interact with algorithmic systems such as YouTube. Additionally, current research into video design rarely considers the contextual realities of classroom education, and these realities may problematise the application of these theoretical principles. At a practical level, there are growing calls for greater policy attention to be paid to the ways in which online data gathering platforms such as YouTube are used in classrooms (Arantes, 2020; Williamson & Hogan, 2020). Yet, I could find no research that explores the current state of teacher use of such systems when selecting and using instructional videos. This research aims to provide a grounding for such policy work, by offering insights into teacher practices in ordinary classrooms.

This study aims to investigate how teachers select and use instructional videos, interrogating the influence of teacher knowledge and the contexts in which teachers work. In doing so, this study consciously avoids searching for so called best practices or "state-of-the-art" video use, and instead seeks to analyse the "state-of-the-actual" (Selwyn, 2008, p. 83). This is because:

> Oftentimes, mainstream writing and research on education and digital technology is proud to pitch 'what if?' and 'what could?' questions. Reflecting on previous failures and present-day compromises seems much less important than looking toward emerging trends and expected transformations. (Selwyn, 2019, p. 1)

It is important to investigate the actual practices of secondary teachers, rather than some ideal, precisely because it is in doing so that compromises arising from labour realities and applied wisdom of practice may emerge. While not the central aim of the study, these contextual factors may also contribute to the literature concerning instructional video design, which has largely been derived from experimental designs.

Furthermore, in light of the rise of algorithmically based platforms like YouTube, interrogating the actual search practices of teachers may shed light on notions of the role of software in mediating curriculum development (Edwards, 2015). With this in mind, the present study seeks to investigate the knowledge teachers draw on when selecting and using instructional videos, and the compromises and contextual realities inherent in the messiness of teacher labour.

1.2 Defining instructional videos

This section offers definitions for the key term *video*, and in particular *instructional* video. A distinction has been made in the literature between *video*, which "captures images of the outside world" and *animation* which is a constructed series of images designed to "trigger the perception of continuous change" (Lowe & Schnotz, 2014, p. 515). However, some authors

(Boucheix & Forestier, 2017; Castro-Alonso et al., 2015) term the instructional materials in their studies *animations* even when they are actually live captured video. These definitions are not only confusing, but perhaps counterintuitive for practising teachers for whom distinctions between live shot and animated content may seem theoretical. As a result, I adopt the more inclusive definition of video offered by Ibrahim et al. (2012): "a format of presenting information as a stream of dynamic visual and auditory content" (p. 220). This definition is broad enough to include live shot action and cartoon or computer-generated animation, mirroring the way the teachers in this study used the term video.

Instructional videos differ from other narrative and entertainment video media used in education such as TV and film, in that content, concepts and skills are explicitly explained (Winslett, 2014). While Ten Hove and van der Meij (2015) have defined instructional videos as those that convey "factual and conceptual information" (p. 49), the breadth of videos reviewed for this thesis suggests that a fuller definition also includes procedural or skills-based knowledge. While factual and conceptual could include a lecture or documentary, procedural and skills-based could include a tutorial on how to use a piece of equipment, how to write a paragraph, or how to search a database (see Section 3.2.3 for a more thorough exploration of various instructional video styles). Therefore, the following definition of instructional videos is adopted for this thesis; a playable stream of dynamic visuals and audio that presents factual, conceptual, or procedural content.

1.3 Research questions and method

This study is driven by a single research question with two sub-questions.

RQ: How do teachers select and use instructional videos?

SQ1: What role does teacher knowledge play in the selection and use of instructional videos?

SQ2: What role does context play in the selection and use of instructional videos?

Through the main research question, I seek to address the current lack of research into the ways in which teachers *actually* select and use videos, rather than how they *should*. However, as discussed in the literature review, there are a range of approaches to understanding the selection and pedagogical use of educational technologies. The first sub question is guided by Shulman's (1986, 1987) framework of teacher knowledge and focuses on interrogating teacher actions. Following Shulman's (1987) own line of enquiry, I seek not only to understand how teachers select and use instructional videos in their teaching, but "what teachers knew (or failed to know) that permitted them to teach in a particular manner" (p. 5).

Consistent with both Shulman's framework, and the TPACK framework, the second sub question recognises that teachers do not enact knowledge in a vacuum, but that contexts play an integral role in moderating their action (Philipp & Kunter, 2013; Rosenberg & Koehler, 2015b). It would be possible to analyse teacher selection and use of instructional videos from other perspectives, but this thesis concentrates on the lenses of teacher knowledge and context, central to Shulman's framework. This means that other factors previously identified as important in teacher use of various technologies, such as availability of technology (Tarus et al., 2015), identity (Phillips, 2014), and school leadership (Keane & Keane, 2016) will be addressed only secondarily.

Conceptualisations of teacher knowledge vary widely in the literature, often as extensions, clarifications, or adaptations of Shulman's work. While acknowledging Mishra and Koehler's (2006) caution that parsing teacher knowledge "is an analytic act and one that is difficult to tease out in practice" (p. 1029), the clear classifications of knowledge in Shulman's

(1986) original framework afford an analytic clarity that allows this research to investigate the role of particular knowledge types in teacher selection and use of instructional videos. The selective use of Mishra and Koehler's (2006) TPACK framework where appropriate allows this research to examine to role of technological knowledge (TK) when it emerges as an important influence (Cox, 2008).

This study uses a multiple case study method with nine teachers across two Catholic secondary schools in the eastern suburbs of Melbourne, Australia (see Chapter 5). The study analyses teacher actions in mainstream schools in a highly contextualised manner, allowing the realities of classroom practice to speak back (Flyvbjerg, 2006) to theory. While this methodology (described in detail in Chapter 4) limits generalisability it provides the scope to offer "rich, thick descriptions" (Merriam, 1998, p. 227) of teacher practices. Such descriptions do not seek to establish external validity, but instead are offered to establish transferability, meaning the ability for a reader to apply the findings to a new situation in their own context (Merriam, 2009).

1.4 Overview of chapters

The remaining chapters of this thesis are organised according to the following structure:

Chapter 2: Literature review – Teacher Knowledge and Reasoning

The second chapter provides an overview of the literature on teacher knowledge. It has a particular focus on Shulman's (1986, 1987) framework of teacher knowledge and the subsequent developments of this framework including Mishra and Koehler's (2006) work on TPACK. The chapter begins with a brief evaluation of various models of teacher knowledge before establishing the reasons for adopting Shulman's original framework as the primary analytic tool for this study. The remainder of the chapter explains in some detail Shulman's understanding of teacher knowledge types, the sources of this knowledge, and the forms this knowledge takes.

Chapter 3: Literature review – Effective Instructional Videos

Chapter 3 is an overview of a broad scope of literature dealing with effective selection and use of instructional videos. It begins with an exploration of the ways past researchers have argued that videos are pedagogically useful. This section also critically examines video-based learning approaches such as blended and flipped learning, and the rather scant prior research on in-class use of videos. Next, the chapter describes the kinds of instructional videos described in the literature. Importantly, this section includes a review of the inconsistent nomenclature used to describe videos in the literature and offers a new classification table as an attempt to unify these previous attempts.

The second part of the chapter describes principles of video design and the two related cognitive theories that underpin much of that research, CLT and CTML. The chapter critically reviews these "cold cognition" (Park, Knorzer et. al., 2015, p. 267) theories and outlines a relatively new theoretical approach called the integrated cognitive affective model of learning from multimedia (ICALM) (Plass & Kaplan, 2016) which considers the interplay of cognition and emotion when learning from multimedia such as video. A systematic review isolating 110 studies that used instructional videos as the learning materials was conducted for this study. The chapter concludes with an overview of the findings from this review, and the design principles that were shown to have a positive impact on learning from instructional videos specifically.

Chapter 4: Case Study Methodology

Chapter 4 argues that a qualitative multiple case study methodology is the most appropriate way of investigating the selection and use of instructional videos and the knowledge base teachers draw on when making these decisions. It describes two approaches to case study research, namely those advocated by Yin (2009) and Merriam (1998) and justifies the adoption of an approach drawing from both methodologists. It outlines and justifies the selection of participants, and the methods of data collection and analysis in light of the various challenges inherent in case study research. In particular, issues of credibility, triangulation of data, and transferability are addressed.

Chapter 4 also outlines the conceptual framework adopted for this study, establishing a research approach based on investigating the state-of-the-actual (Selwyn, 2008) as opposed to notions of best practice. To do so, Shulman's (1986, 1987) framework is used to make sense of the knowledge teachers draw on when selecting and using instructional videos. Much of this knowledge is tacit, and so the cognitive theories introduced in Chapter 3 are used to provide language by which this wisdom of practice can be discussed and compared.

Chapter 5: Case and Context – Introducing the participants

In this brief chapter the nine participants are introduced as individuals practice (see Table 8, Section 5.1.1, and Table 9, Section 5.2.1), through a description of their professional experience, their attitude to technology and pedagogy more generally, and the videos they used in their. In addition, the two school contexts in which the data were collected are described to aid the reader in establishing transferability to other contexts. The two Catholic schools in the Eastern suburbs of Melbourne had socio-economic and student achievement profiles positioning them as mainstream, unexceptional schools. The word unexceptional is chosen deliberately, not to imply any deficiency, but instead to communicate that the schools were neither above nor below average and were typical Victorian secondary schools.

Chapter 6: Knowledge in the selection and use of instructional videos

This Chapter, the first and longest of the two analysis chapters, explores the impact of teacher knowledge on the selection and use of instructional videos. Using Shulman's (1986, 1987) framework, the analysis is presented in four sections (knowledge of students, curricular knowledge, content knowledge, and pedagogical content knowledge (PCK)/TPACK), each analysing a particularly impactful knowledge type. Cases are compared, and a range of empirical and theoretical propositions are drawn from the data.

Chapter 7: The influence of context

The second analysis chapter recognises that teacher knowledge is not enacted in a vacuum but is instead bounded and affected by the contexts in which teachers labour. The Chapter is organised into a discussion of micro, meso, and macro-contextual factors that have not been discussed in the previous chapter. Consistent with the findings of Loughran et al. (2016) and (Philipp & Kunter, 2013), teacher perception of time poverty and the tendency to act in isolation rather than through collaboration emerged as important factors affecting selection and use of instructional videos. The dominance of the YouTube platform and the algorithms that manage it also emerged as an important influence on the video content teachers choose from. Much of this chapter explores the nature of this platform and the ways in which teachers interacted with it. Drawing on a growing field of scholarship into the way YouTube acts as a user-generated yet commercial system, the chapter makes suggestions as to the ways in which the platform bounds teacher practices.

Chapter 8: Conclusion

The final chapter presents a summary of the research findings, and presents ten theoretical or empirical propositions, five implications for practice, and seven future research directions. Amongst the theoretical propositions are a range of implications for TPACK, Shulman's framework of teacher knowledge, and the ways in which CLT/CTML can be applied to classroom practices.

Chapter 2: Teacher Knowledge

As Koehler et al. (2013) so aptly summarised, “teaching is a complicated practice that requires an interweaving of many kinds of specialized knowledge” (p. 13). Shulman (1986, 1987) parsed what he saw as the basis of this specialised teacher knowledge into categories and described the role these play in pedagogical reasoning and action (PR&A). The result has been aptly described as a “framework” (Mecoli, 2013, p. 21) of teacher knowledge. Shulman (1987) constructed his framework in response to what he saw as “trivial definitions of teaching held by the policy community” (p. 20) in the United States. In particular, he argued that teacher education and evaluation had swayed too far in favour of ensuring certain teaching behaviours, to the detriment of developing knowledge. Shulman (1987) saw content knowledge, and the reasoning processes of expert pedagogues when drawing on that knowledge, as a “missing paradigm” (p. 6) in educational research. This chapter outlines Shulman’s framework of the knowledge base for teaching, the sources of that knowledge, and forms that knowledge takes. Along the way, I apply this framework to the specific pedagogical act of selecting and using educational video content.

Shulman has subsequently described his framework as simultaneously a “cognitive theory,” a “policy claim” and an “ideological claim” (Shulman, 2012, cited in Gess-Newsome, 2015, p. 29). Shulman’s framework is, by his own description, a normative model, shaped by his observations of what he saw as exceptional teachers, and his desire to “make the emergence of such teachers more likely” (1987, p. 20). Knowledge of this motive frames the normative demands of the framework as aspirational, rather than an attempt to describe typical teacher practices.

Shulman’s framework is certainly not the only attempt theorists have made at describing the knowledge competent teachers use to make and enact pedagogical decisions. It is, however, suited to describing the central phenomenon of this thesis, because Shulman highlights the knowledge teachers use in planning for pedagogical action, and reflecting on those pedagogical episodes. The selection and use of instructional videos are just such an example of planning and enaction. In contrast, for example, Schön’s (1987) model of reflection-in-action describes the way expert teachers are able to engage in real-time, spontaneous reasoning based on tacit knowledge.

Boney (2014) explains that while Shulman is concerned with the selection and transformation of “some type of text” (p. 58), Schön is more concerned with the active reasoning process during performance, with an emphasis on artistry (see also Eisner, 2002). Given that this research is investigating the selection and use of a particular type of “text”, namely instructional videos, Shulman’s model is a better fit. Furthermore, given that this thesis deals with teacher use of technology, further depth of explanation about the terms developed by Shulman has been drawn from the work of theorists in the field of TPACK and the importance of this work is briefly outlined, as a special case of PCK (Phillips & Harris, 2018). This chapter is divided into three sections exploring:

1. Shulman’s categories of knowledge and TPACK (Section 2.1);
2. the common sources of teacher knowledge (Section 6.2); and
3. the forms teacher knowledge can take (Section 6.3).

2.1 Knowledge base for teaching

In a series of articles from 1986-1991, Shulman set out to enumerate and explain the kinds of knowledge that effective teachers develop and draw on when making and enacting pedagogical decisions. At the heart of this knowledge base is PCK, the knowledge used by teachers to make decisions about how to teach specific content to specific students. PCK is, however, more than the sum of its parts, namely pedagogical knowledge (PK) and content knowledge (CK). It is important to note that Shulman made no claim to have comprehensively described the knowledge base for teaching, instead arguing his (at times changing) list of seven types of knowledge described the "minimum" (1987, p. 8) needed. At one point, after mentioning knowledge of pedagogy, content, and curriculum, Shulman (1987) adds in parentheses:

> There are clearly other important domains of knowledge as well, for example, of individual differences among students, of generic methods of classroom organization and management, of the history and philosophy of education, and of school finance and administration, to name but a few. (p. 10)

He adds that even these are "subdivided into categories" (p. 10). Indeed, Hashweh (2013) argues that:

> By proposing PCK as one of seven categories of the knowledge base, and by neglecting the interactions among the other categories, the hierarchies that might exist between them, or the different forms or types of knowledge within each category, Shulman left the task of further developing the conceptualization of PCK to others. (p. 117)

The exact number of knowledge types that form a teacher's knowledge is a matter of some theoretical disagreement and by his own admission Shulman (1987) does not display "great cross-article consistency" (p. 8). Some have suggested only three types of knowledge - PK, CK, and PCK (Gess-Newsome, 1999), with all other types of knowledge as components of PCK (Hashweh, 2013). Other researchers (Endacott & Sturtz, 2015; Phillips & Harris, 2018; Verloop et al., 2001; Wilson et al., 1987) include additional types of knowledge, at times multiplying, or perhaps more accurately dividing these to get up to 31 knowledge types as in the TPACK-XL framework (Saad et al., 2012). It is entirely possible that one could parse teacher knowledge into far more numerous lists and indeed the demarcation between knowledge types has been criticised as lacking clear distinctions (Graham, 2011; Magnusson et al., 1999). Arguably, these other categories are contained within Shulman's seven knowledge types plus the addition of technological knowledge outlined in this section. Because the technology used by teachers in this study was largely what Cox (2008) would consider transparent (see Section 2.1.7), for the sake of simplicity Shulman's list will be used to discuss the influence of knowledge on the use of instructional videos, with the TPACK framework used when required.

It should be noted that knowledge is not action, but rather motivates or informs what Shulman (1987) called PR&A. PR&A is a thinking and acting process by which teachers apply their knowledge, comprehending and transforming subject matter for students then planning, instructing, evaluating and reflecting upon teaching experiences (Loughran et al., 2016; Shulman, 1987). Given this study examines the actions teachers take when selecting and using instructional videos, the data could well have been analysed through the lens of Shulman's six stages of PR&A. However, a choice was made to focus on the types of knowledge teachers draw on when making particular pedagogical decisions in order to analyse the body of knowledge needed to make effective decisions, and the sources from which this knowledge is constructed.

2.1.1 Pedagogical Knowledge

General pedagogical knowledge (PK) is perhaps the least developed of Shulman's knowledge types. In his 1986 article he only briefly describes PK in the section on PCK, and in 1987 he simply defined it as "those broad principles and strategies of classroom management and organisation that appear to transcend subject matter" (Shulman, 1987, p. 8). In short, PK describes content-independent knowledge about how to teach. Included in this general pedagogical knowledge are classroom management techniques and understandings of "how the mind works to store, process and retrieve information" (Shulman, 1987, p. 11). It is armed with such knowledge that a teacher can more effectively plan the types and amount of material to present to learners at various stage of development. Building on Shulman's rather sparse definition, Morine-Dershimer and Kent (1999) drew the distinction between general pedagogical knowledge, "derived from the research and scholarly literature" (p. 22) and personal pedagogical knowledge, which is "fuelled by personal beliefs and personal practical experiences" (p. 22). While general pedagogical knowledge may include theories and practices found to be effective in teaching literature (such as those described in Chapter 3), personal pedagogical knowledge may include an understanding of the particular classroom management or teaching techniques that a teacher has found effective in their own practice.

It is important to note that "for many teachers, their practice and the knowledge, ideas, and theories that tend to influence that practice are often tacit" (Loughran, 2002, p. 38) rather than clearly articulated. This means that when investigating personal pedagogical knowledge derived from experience, it can fall on the researcher to give theoretical language to what is expressed as very practical, contextually bound pedagogical knowledge. While the coding approach is more thoroughly described in Section 4.6, where possible the theoretical language of CLT/CTML/ICALM (see Section 3.3/3.4) was used as an analytical device to theorise the personal pedagogical knowledge of the teachers in this study. It is important, however, not to shoehorn data into theory. As such, any variance between CLT/CTML as popular theories of instructional video design and the knowledge revealed in the data provides an opportunity to critically evaluate these theories. While not the main focus of this thesis, such emergent findings are nevertheless an interesting point of discussion in the concluding chapter.

2.1.2 Content Knowledge

Shulman (1986, 1987) argues that effective teachers need to know their content domain at least as well as professionals who practise in the field. For instance, a teacher of Geography should know as much about climate science as a working climate scientist. This seems onerous for a teacher who teaches in multiple domains, or even within such a broad domain as General Science. Boney (2014) also recognises this aspirational nature of Shulman's work, and she identifies that there is often a difference between what teachers do (the effective) and what teachers ought to do (the normative). Shulman (1987) himself recognised that in his observations, some teachers "failed to know" (p. 5) what was required to teach effectively.

Building on the work of Schwab (1978), Shulman (1986) argues the need for subject mastery is true of both the corpus of knowledge that constitutes a particular domain, such as Biology or English Literature, and also of the "syntax" and "substantive structure" (p. 9) of that domain. Syntax is described as knowing how new knowledge is generated in a particular field and how new claims are tested. Involved in this is knowledge of the subject's substantive structure, meaning an understanding of the structure of knowledge within the field, and how the particular content to be taught fits within this structure. It is knowledge of this structure and syntax that allows teachers to engage deeply with the 'why' questions of students and to assist students in the construction of knowledge, over and above recall.

The focus of this study is on the knowledge teachers use when selecting and using instructional videos, and in such a context CK may act as a fact checker in the selection of educational videos when searching for reliable resources on user-generated platforms like YouTube, a process that their students may struggle to successfully undertake on their own (Tan & Pearce, 2011). Indeed, given the multitude of videos on a particular topic and the lack of editorial oversight on platforms like YouTube (Arthurs et al., 2018), this skill is arguably more pertinent when dealing with digital platforms than it was when Shulman (1986) suggested teachers needed to be able to deal with "flawed or muddled textbooks" (p. 8).

CK is not unique to teachers. One would expect any competent physicist to be capable of both fact checking and evaluating the syntactical accuracy of an educational video about forces or nuclear power. This knowledge of the subject matter is necessary, but "it is not a sufficient condition for being able to teach" (Wilson et al., 1987, p. 105) because teachers must also know how to communicate that content to novices. The knowledge that is uniquely required by teachers is the synthesis of pedagogical and content knowledge, known as PCK (Cochran et al., 1991).

2.1.3 Pedagogical Content Knowledge

Shulman (1986) theorised the notion of PCK to describe knowledge about how to teach any particular subject matter. It relates a teacher's pedagogical knowledge (their general knowledge about human cognition and how to teach) to their content knowledge (their knowledge of facts and syntax) (Cochran et al., 1991). PCK concerns knowledge about how best to represent content in order to facilitate the learning of that content by particular learners (Shulman, 1986; Wilson et al., 1987). It also includes knowledge of the best methods and processes to use to facilitate the learning of particular content (Shulman, 1986).

Gess-Newsome (1999) presents two models of PCK, one which describes PCK as a teacher's combined pedagogical and content knowledge, and another that sees PCK as a transformation of these knowledge types into a new type of knowledge entirely. Using a metaphor from chemistry, she likens these models to mixtures and compounds. While in the former model, PCK represents a mixture of separate knowledge types, among many that a teacher uses. In the latter model the resultant PCK is the only form of knowledge teachers use. This is similar to the position of Cochran et al. (1991) that PCK represents the confluence of "the four components of pedagogy, subject matter content, student characteristics, and the environmental context of learning" (p. 266). An extreme version of the compound approach was advocated by Park and Oliver (2008) who, seeking to provide a comprehensive definition described PCK as "teachers' understanding and enactment of how to help a group of students understand specific subject matter using multiple instructional strategies, representations, and assessments while working within the contextual, cultural, and social limitations in the learning environment" (p. 264). Given it incorporates both understanding and enactment within a context, such a definition suggests that PCK is, in effect, the whole of teaching.

By drawing together all teacher knowledge into PCK, such compound approaches may not provide the kind of analytic framework that allows investigation of the influence of particular knowledge types on teacher practice. This study will use Shulman's (1991) suggestion that PCK is both a new form of knowledge, but also that it represents only one of the many types of knowledge used by teachers. While this position is "less theoretically powerful or precise than either of the two extremes" (Gess-Newsome, 1999, p. 13) outlined above it allows consideration of pedagogical practices independent of content domain but particular to instructional videos broadly, which is useful when comparing practices of teachers in diverse domains. It also provides the analytic flexibility to examine knowledge types in isolation, even if in practice knowledge types are rarely enacted alone.

A teacher's PCK includes knowledge of the common misconceptions students have when learning a topic at a particular level. It also includes "the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations" (Shulman, 1986, p. 9) to make comprehensible the otherwise incomprehensible. Indeed, Van Driel et al. (1998) suggested that these two elements of PCK were considered as central to the definition by the wide variety of authors that had sought to refine the concept. Because of the particularly domain specific nature of both of these types of knowledge, "teachers who are effective in one field might not automatically be as effective in another area for which they are not suitably qualified" (du Plessis et al., 2014, p. 96).

2.1.4 Curricular Knowledge

While some have included curricular knowledge as an element of PCK (Grossman, 1990; Magnusson et al., 1999), Shulman (1986) conceptualised it as a separate type of content knowledge. He describes curricular knowledge as knowing about:

> the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances. (Shulman, 1986, p. 10)

It is interesting to note that with this focus on knowing the "tools of the trade" (Shulman, 1987, p. 8), his description of curricular knowledge did not initially include knowledge of mandated learning goals, such as those provided by statutory bodies. Later, however, Shulman (1987) noted that teachers derive knowledge from "curricula and their scopes and sequences" (p. 9) and suggested that the texts teachers rely on could include "a textbook, a syllabus, or an actual piece of material the teacher or student wishes to have understood" (p. 14). A PCK summit of science education researchers in 2012 added to Shulman's definition, arguing that "curricular knowledge might include the goals of a curriculum, curriculum structures, the role of a scope and sequence, and the ability to assess a curriculum for coherence and articulation" (Gess-Newsome, 2015, p. 29). But even in this consensus definition, 'a curriculum' is left undefined. From among these rather fragmented definitions, I conclude that curricular knowledge encompasses knowledge of three sources of curriculum:

1. the mandated curriculum, such as that prescribed by the state or school district and interpreted in local school contexts;

2. prescribed textbooks, such as those chosen to be common amongst all students studying a subject at a particular school;
3. other curricular materials that a teacher may draw on where appropriate.

Notably, the last category would include a catalogue of instructional videos. Curricular knowledge also extends to knowledge of how to select and discern between curricular materials, Shulman's *indications* and *contraindications*. In Chapter 6 it will be argued that the exponential growth in available resources on platforms like YouTube means that curricular knowledge should also be extended to include search techniques and knowledge of what makes for effective instructional videos.

For teachers in the context of mainstream Victorian secondary schools like the two in this study, the state government mandated curriculum written by the Victorian Curriculum Assessment Authority (VCAA), both F-10 (5-16 years) and the Victorian Certificate of Education (VCE, 16-18 years), is the primary curriculum document that determines the content taught. In addition to this, Catholic schools such as those in this study are mandated to teach Religious Education programs controlled at a diocesan, rather than state, level. In the broader definition described above, curricular knowledge also entails school curriculum documentation, which is the local interpretation of these mandated goals. Highlighting the messiness of parsing teacher knowledge, this type of curricular knowledge also draws on knowledge of educational contexts (Shulman, 1987) and so will change when a teacher moves schools, even more so when that school is governed by a new body. Within the particular curriculum they teach, Shulman argues that teachers should hold lateral curriculum knowledge (awareness of those topics being studied by the same students in other subject domains), and vertical curriculum knowledge, (awareness of the trajectory of student learning in the same subject).

This curricular knowledge has three main implications for teachers when selecting instructional video content for students. Firstly, teachers should be aware of the variety of existing educational videos and video platforms relating to the topics they teach. Given the rapidly expanding range of videos offered on YouTube and other platforms (Lucas & Abd Rahim, 2017), this is a particularly challenging demand. Next, teachers should be able to determine whether a particular explanation offered in a given video is consistent with the study design mandated by the curriculum. Finally, teachers draw on knowledge about how to search on different platforms, and how the content or nature of those platforms affect the likely search returns.

2.1.5 Knowledge of Learners

Teachers do not simply teach content, they teach it to "a particular group of students, who learn in particular ways at a particular time of day" (Wilson et al., 1987, pp. 107-108). While pedagogical knowledge concerns how students learn in general, knowledge of students can be understood as the knowledge of the particular students a teacher is required to teach. So, while pedagogical knowledge includes such general rules as *students learn best from spaced practice*, knowledge of learners might include an understanding that *Rodney and James concentrate well when put in a group together*, or *my Year 9 class thinks Bill Nye the Science Guy is corny* (see Section 6.1.2). This knowledge of students has also been termed "context-specific pedagogical knowledge" (Morine-Dershimer & Kent, 1999, p. 24).

While not the central focus of Shulman's work, which centred on addressing what he saw as a lack of research on teacher content knowledge, knowledge of students is a fundamental source of knowledge teachers use to reason. Wilson and Shulman (1987) recounted an anecdote of one beginning teacher who introduced Shakespeare's Julius Caesar by recasting the play into the context of Star Trek. The teacher drew on his knowledge that these students knew about Captain Kirk, as well as his knowledge of Shakespeare's play, to create a rich and engaging learning activity. This knowledge of specific learners is not static. One cannot imagine the Star Trek activity would have the same impact on learners in the twenty first century, who would likely know nothing of Captain Kirk. Indeed, an understanding of the culture, interests, and prior knowledge of the learners in a particular classroom is a particularly dynamic form of knowledge.

2.1.6 Knowledge of Educational Contexts

While not included in his 1986 article, a year later Shulman (1987) had added knowledge of educational contexts to the list of teacher knowledge types. He defined context broadly, "ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures" (1987, p. 8). Context has been examined extensively since, often in light of its influence on knowledge, rather than the knowledge of context, and the field has been said to suffer from a certain "messiness" (Phillips et al., 2016, p. 3030).

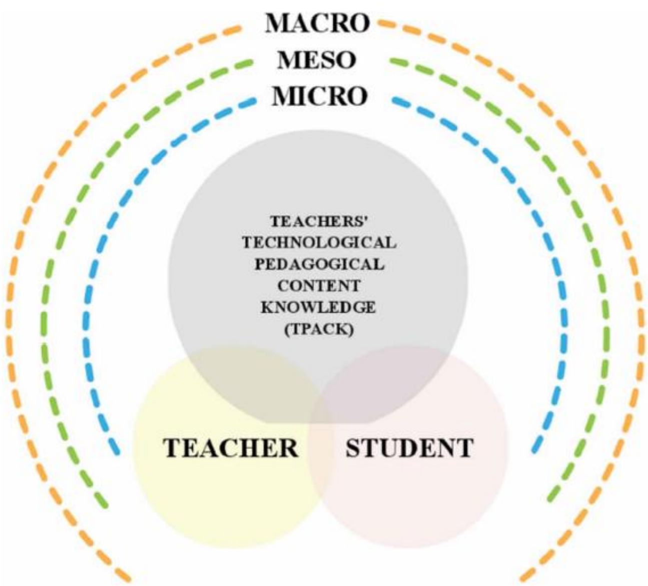
A potentially helpful framework to make sense of the way context impacts on teacher enaction of knowledge is that proposed by Porras-Hernández and Salinas-Amescua (2013) and extended by Rosenberg and Koehler (2015a), which separates contextual factors into micro, meso, and macro, which are all in relationship with the actions of teachers. This model places teachers and students at the centre of three concentric contextual circles (see Figure 1) which act upon and mediate the practices of teachers in enacting their knowledge. This framework was initially conceived to explain the impacts of context on TPACK development, but Rosenberg and Koehler (2015a) suggest:

> The framework as it is designed then has applications well beyond TPACK. Indeed, the framework may be used to think about a wide scope of educational technology topics and their rich interactions with context. Particularly relevant to this chapter are topics related to teaching with technology in the digital age. That is, one could easily imagine a number of easy substitutions in Figure [1] for the grey circle representing TPACK, including teachers' beliefs about technology use, their creativity, and their pedagogical practice, as well as students' prior knowledge, their problem solving skill, and their engagement in classroom and disciplinary practices. The characteristics of others involved with teaching with technology, including teachers in informal educational settings, parents, and even peers engaged in teaching one another, could also be substituted for TPACK as the focus of the framework. In short, because the framework can be used to think and talk about context in teaching, it offers a fundamental way to think about wide scope of educational technology topics that involve teachers, students, and their rich interactions with context. (p. 447)

While this framework describes the impact of context on knowledge, it is equally valid, as Shulman asserted, to discuss teacher knowledge *of* those contexts.

Figure 1:

Conceptual framework for context as represented by Rosenberg and Koehler (2015, p. 447)



Micro factors are those that occur within the learning environment, such as available technologies, subject matter, and room design (Rosenberg & Koehler, 2015b). Highlighting the reality that teacher knowledge is hard to parse, knowledge of these micro-contexts includes some overlap with other knowledge types, most noticeably knowledge of students. Meso factors include functions of school organisation in which the learning environment exists, such as the availability of support staff, timetable considerations affecting perceptions of teacher time (Marshall, 2016), school culture, and the vast array of school policies. The communities of practice in which teachers operate can be an influential aspect of this meso context, particularly those in which pedagogical decisions and shared understandings of teaching are negotiated (Henderson, 2007; Keane & Keane, 2017; Wenger, 1998). Macro factors are comprised of those influences that are dictated by society or government, such as state school curricula, child protection policies, state technology restrictions, and national testing regimes.

Finally, in an environment in which algorithms and artificial intelligence are playing a more important role, it may be time to start considering hidden or opaque contexts that remain unacknowledged. This is discussed more fully in Chapter 7, particularly with reference to the YouTube algorithms, which emerges as a common source of instructional videos for the participants. The key literature surrounding the YouTube algorithm, and *human-software entanglement* (Edwards, 2015) is introduced there.

2.1.7 TPACK

In the thirty plus years since Shulman's 1986 introduction of PCK and the framework for teacher knowledge there has been such a wide array of research studies developing the idea that even less than ten years later it was described as "a small cottage industry" (Nelson, 1992, p. 32). In one such development, Mishra and Koehler (2006) suggested that the growing importance of technology in the work of teachers drew on another type of knowledge, technological knowledge (TK) to add to CK and PK. As Phillips et al. (2017) neatly summarise, "this framework resulted in seven potential forms of teachers' professional knowledge with the aspirational TPACK positioned at the nexus of these circles" (p. 2422). In other words, when teachers plan with emerging technology, they combine TK, CK, TPK (technological pedagogical knowledge), and TCK (technological content knowledge) to develop TPACK. Cox (2008) further refined this framework, theorising a "sliding nature of TCK, TPK, and TPACK" (p. 78) whereby technologies become transparent over time, in that:

> As particular technologies become ubiquitous in the classroom, the focus on those technologies is no longer necessary. Thus, TPACK becomes PCK as the technology becomes transparent. While this is a new claim, it seems to be supported by the vision of TPACK as a somewhat temporary framework expressed in the interviews with TPACK researchers. Additional support for this perception is found in Shulman's early definitions of PCK which included technology as a pedagogical and curricular tool. (p. 99)

The transparency of a technology, meaning the degree to which a teacher actively considers the affordances and features of the technology, is determined by the teacher and their context, not the technology itself. In terms of instructional videos, the platforms used to search for videos, and the technology used to display them may be considered either transparent or emerging, depending on the teacher. In Chapter 7 examples are introduced of teachers who consider the YouTube platform transparent, yet are unaware of many of its features, or the hidden influence of its algorithms on their practice. This suggests that there may be such a thing as a falsely transparent technology. These are technologies which the teacher unthinkingly uses but does not fully comprehend.

Ultimately, TPACK describes the type of knowledge a teacher draws on and develops when considering the purposeful use of emerging technology to teach specific content to specific learners. Graham (2011) points out that despite wide adoption of the TPACK framework, little theoretical development has occurred. More recently Phillips and Harris (2018) found that despite the approximately 1300 publications utilising the TPACK construct in the past 15 years, there is a lack of consensus on definitions of the construct or its components. This study accepts the argument of Phillips and Harris (2018) that TPACK is a special case of PCK. As such, the technological aspects of teacher knowledge will be discussed when teachers make specific reference to their thinking around technology.

2.2 Sources of Knowledge

Knowledge is not innate; it is constructed by the learner from various sources. This is equally true for teacher knowledge, and this section outlines the four sources from which Shulman (1987) suggests teachers construct their knowledge. These are:

(1) scholarship regarding content to be taught;

(2) the materials and settings of educational institutions (curricula, textbooks, school organisational structures etc.);

(3) scholarship regarding education, human learning and schooling; and

(4) the wisdom of practice derived from personal experience and the experience of others.

The four sources Shulman proposes describe the two fundamentally different kinds of knowledge drawn upon by teachers. The first three sources describe the *episteme* of teaching (Eisner, 2002), which the Greeks understood to be knowledge that is objectively justified. Knowledge of the first and third categories are drawn from scholarship and concern "the accepted truths in the domain" (Shulman, 1986, p. 9) and "the findings and methods of empirical research" (Shulman, 1987, p. 10). Examples of this type of research concerning the use of instructional videos is outlined in Chapter 3. Knowledge of the materials and settings of educational institutions are presented in similarly positivist language. While such knowledge is important, Eisner (2002) suggests teaching in real educational contexts is "messy and unpredictable" (p. 378) and "each child [needs] to be known individually, at least as far as possible" (p. 381). Dealing with practical situations rarely calls for the implementation of rigid rules, which would see teachers as those who simply "implement the prescriptions of others" (Eisner, 2002, p. 381). Instead, Chapter 6 will reveal that much of the knowledge teachers draw on comes from the Shulman's final category, wisdom of practice, what the Greeks referred to as *phronesis* or "practical, craft knowledge" (Phillips et al., 2017, p. 2425).

PCK emerges when teachers draw on these knowledge sources, critically reflecting and evaluating the subject matter, transforming and tailoring it into representations most suitable for the particular students who will be taught (Cochran et al., 1991). This section will outline each of these knowledge sources, with an emphasis on what sources teachers may draw on when selecting instructional videos.

2.2.1 Content Scholarship

In Australia, teachers theoretically acquire their initial content scholarship during the minimum four years of tertiary study required to register as a teacher (Weldon, 2015). The Australian Council for Educational Research (ACER) considers a teacher qualified in a particular subject domain if they have studied that subject beyond a first year university level, and have also studied a subject teaching methodology (Weldon, 2016). Highlighting a major difference between the Australian context and the American context for which Shulman was writing, Ingersoll et al. (2014) define qualification to teach a particular study in the United States as a teacher who has completed at least a major sequence in that domain. This is the assumption that Shulman (1986) makes about teacher content knowledge although he admits the assumption may be unfounded. Troublingly, both the Australian and American definition consider a science teacher qualified if they hold an undergraduate or postgraduate degree in any of the major domains of science - biology, physics, earth sciences, or chemistry - despite the reality that these domains are diverse fields with distinct subject matter. This feeling of being out-of-field while being in-field was a major concern of science teachers in this study (see Chapter 6).

Neither of these definitions meets Shulman's (1986) suggestion that teachers should possess equal content knowledge to practitioners in the field. Nor could a major sequence prepare a teacher to deliver lessons on the wide variety of topics covered in the various curricula in Australia. Indeed, even if a teacher were to complete an entire undergraduate degree in History, they may not study a single semester of Egyptian history yet would be by either definition qualified to teach a secondary school course in that topic.

Because of the gap between the entry requirements of teaching and the actual content demands of everyday teaching practice, teachers are often required to seek additional sources for content knowledge throughout their career. This is exacerbated by the incidence of out-of-field teaching, in which a teacher is asked to teach a course in a subject for which they are not qualified. According to ACER, 26% of teachers teach outside of their field with approximately 40% of Geography teachers, 38% of Religious Studies teachers and 41% of Media teachers failing to satisfy ACER's threshold for qualification (Weldon, 2016). Weldon blames this state of affairs partly on small Australian school sizes and a pressure to place the most qualified teachers in senior classes, a claim supported by du Plessis et al. (2014) who found that many school leaders assume that a teacher should "be able to teach anything up to year nine" (p. 95). Whatever the genesis of this phenomenon, the reality remains that many teachers do not acquire their content knowledge from formal tertiary study and are required to self-educate on the topics they need to teach.

This has implications for the ways in which different teachers select videos. While teachers with high CK have been shown to be adept at accurately evaluating the factual and syntactical accuracy of a particular video (Holmberg et al., 2018), out-of-field or topic novice teachers may instead use such videos as sources of subject knowledge. Teachers teaching out-of-field are routinely expected to "just get on with it" and "teach themselves" (du Plessis et al., 2014, p. 95) and videos may play a role in this at times lonely process. This research contributes to the literature on this phenomenon.

Tan and Pearce (2011) discovered a potential danger of using videos for self-education when they studied a UK tertiary sociology course. A student sent the lecturer what they thought was a useful video outlining a feminist perspective on sociology, only to have it explained that it was a parody of feminism posted by an American right-wing group. While in this situation the lecturer was an expert in the content and syntax of sociology and was therefore able to spot the true nature of the video, by the ACER definition the student was almost qualified to teach humanities at a secondary level. Had the student not been expertly guided by their lecturer, they may one day have displayed this video as seemingly reliable content in a classroom or at the very least used it as the basis for their own (mis)understanding of feminism. This highlights the reality that the availability of video, particularly on user generated platforms like YouTube, in no way reduces the role of content knowledge and scholarship on the part of educators.

2.2.2 Educational Settings

Shulman (1987) suggests teachers need to "know the territory of teaching" (p. 9) including the "overlapping classroom, school, district [systemic], department, and policy contexts" (Ruppar et al., 2015, p. 211). This knowledge is gained from curriculum documentation, explicit and implicit rules derived both at governmental levels and locally, and the preparation offered in pre-service teaching courses.

This source of knowledge informs teachers about what educational videos are able to be shown at a very practical level. Content may be demanded or precluded by curriculum. Just as importantly, teachers may rely on ICT policy to determine possible and acceptable use of technology in any particular classroom. The pedagogical possibilities in a 1:1 technology environment are vastly different to a classroom in which only the teacher has access to a video playing device, for instance by using a projector, or if a teacher needs to move their class to another location to watch a video. In addition to policy; school-wide, faculty, and teacher team cultures play an important role in motivating or demotivating use of educational technologies (Keane & Keane, 2017).

2.2.3 Pedagogical Scholarship

Pedagogical scholarship is the episteme of pedagogy. Shulman (1987) describes it as the "growing body of scholarly literature devoted to understanding the processes of schooling, teaching and learning" (p. 10). He suggests teachers should be well versed not only in the empirically based works dealing with pedagogy, but more importantly the "normative and theoretical aspects of teaching's scholarly knowledge" (p. 10), including how the mind works. As with content scholarship, Australian pre-service teachers are expected to study pedagogical and developmental psychology theory during their minimum four-year tertiary study.

In addition, schools offer ongoing professional learning opportunities (Duncan-Howell, 2010). In Australia, schools regularly offer teachers access to vast databases of academic literature on pedagogy, but MacLellan (2016) highlights the reality that teachers rarely engage with educational research because it is written for fellow researchers, rather than practitioners. MacLellan (2016) recounts the frustration of researcher and secondary school teacher who found that a reasonably simple classroom activity that could be explained to a Biology teacher on one A4 sheet required 14 pages when published in an academic journal. In recent research, under half of teachers enrolled in a voluntary professional development course on STEM practices reported using educational research to inform their practices, despite these teachers arguably being more likely to use such research than the general population (Booher et al., 2020).

Duncan-Howell (2010) argues there is a need to develop tools to operationalise academic research for practitioners and encourage learning with colleagues rather than reliance on passive input from outside experts divorced from the practical context of the community. Regardless, this research will investigate the extent to which academic pedagogical scholarship regarding effective video design and use (such as that outlined in Chapter 3) influences teachers when they make pedagogical decisions. This knowledge may make an important contribution to discussions about the content of initial teacher training programs in an age in which instructional videos are becoming ubiquitous.

2.2.4 Wisdom of Practice

What Shulman (1987) termed “wisdom of practice” (p. 11) describes knowledge derived from the experience of teachers. It also includes the experiences of other educators within a community of practice. Such knowledge is also understood as phronesis, Aristotle’s virtue of practical wisdom, as differentiated from episteme, or formal knowledge (Boney, 2014; Eisner, 2002; Kinsella & Pitman, 2012; Phillips et al., 2017). Finally, Van Driel et al. (1998) labelled wisdom of practice *craft knowledge*, meaning the “accumulated wisdom with respect to their teaching practice" (p. 674). Hashweh (2013) argues that PCK is inherently wisdom of practice, because it is "a form of knowledge that preserves the planning and wisdom of practice that the teacher acquires when repeatedly teaching a certain topic" (p. 137). PCK is not simply a theoretical confluence of pedagogical scholarship and content scholarship but emerges in praxis and is honed through experience. Similarly, Wilson et al. (1987) describe the development of PCK as a process of transformation, by which the various forms of knowledge are applied to specific teaching episodes. As the teacher plans, adapts, instructs and evaluates, their knowledge base as applied to teaching grows, manifested particularly in expressions of PCK. This wisdom of practice is not positioned in opposition to theoretical or scientific knowledge, but may involve such knowledge being transformed, contextualised, filtered through personal beliefs and backgrounds, and refined through lived experience (Van Driel et al., 1998). This study investigates the role of wisdom of practice in the selection and use of instructional videos, and questions whether its impact is mediated by the use of relatively new technology.

One of the challenges when recording and analysing teacher wisdom of practice is that few teachers have the "time, expectation, or obvious reason to engage in discussions helping them to develop tacit knowledge of their professional experience into explicit, articulable forms" (Loughran et al., 2004, p. 373). While teachers often make decisions based on a complex understanding of learning and learners, they may not possess precise language with which to describe this understanding, or their reasoning can be expressed relative to highly contextualised classroom events (Kagan, 1990). To consider commonalities and differences across the wisdom of practice of teachers, it can be necessary to introduce a common structure to these reflections. Shulman's (1986, 1987) framework does not provide such a structure beyond suggesting categories of knowledge.

In this study, teacher statements about student learning and the effective design and use of videos emerging from wisdom of practice are viewed through the lens of CLT/CTML. The principles of video design emerging from these theories, and the theorised explanations of student cognition when learning from multimedia like videos provides a theoretical framework for what is otherwise rather imprecisely expressed language. By comparing teacher wisdom of practice to the theoretical and design principles of CLT/CTML, a comparison between the two is afforded. While not the focus of this thesis, this comparison gives rise to emergent, unexpected implications for both teacher knowledge and the role of context in CLT/CTML. The data coding process is described in more detail in Chapter 4, while discussion of the analysis of these comparisons emerges in Chapters 6-8.

2.3 Forms of knowledge

Shulman (1986) proposes that each category of teacher knowledge exists in three forms, propositional knowledge, case knowledge, and strategic knowledge. Shulman argues that all three forms of knowledge empower teachers to engage in the “wicked problem” (Rittel & Webber, 1973) of pedagogical reasoning and action.

2.3.1 Propositional knowledge

Propositional knowledge is the form of knowledge that is presented as lists of best practice for teaching. Shulman (1986) gives examples such as “planning five-step lesson plans, never smiling until Christmas, and organizing three reading groups” (p. 10). This form of knowledge can be further parsed into principles, maxims, and norms. *Principles* of teaching, (such as the principles of instructional video design and use presented in Section 3.5) are largely derived from research and describe those practices in the literature that have been shown to improve educational outcomes. These principles represent the episteme of teaching. Principles, while often backed by empirical evidence, are theoretically bound. On the other hand, *maxims* "represent the accumulated wisdom of practice, and in many cases are as important a source of guidance for practice as the theory or empirical principles" (Shulman, 1986, p. 10). Maxims could be described as the tricks of the trade. Finally, *norms* describe the ethics and philosophy of teaching, true not because they work "but because they are morally or ethically right" (Shulman, 1986, p. 10). Normative knowledge includes ideas such as giving students a fair turn, protecting the vulnerable, and ensuring a positive environment in the classroom. Propositions, Shulman argues, are both efficient in their prescriptiveness and simplicity, but also abstracted from context and therefore need to be applied to specific circumstances by each teacher.

2.3.2 Case Knowledge

Shulman (1986) borrows the idea of case knowledge from the study of law, in which students examine the application of laws (propositions) to the specifics of actual cases. Case studies illuminate both practical application and reveal theory to those studying them. Shulman explains:

> A case, properly understood, is not simply the report of an event or incident. To call something a case is to make a theoretical claim-to argue that it is a 'case of something,' or to argue that it is an instance of a larger class. A red rash on the face is not a case of something until the observer has invoked theoretical knowledge of disease. A case of direct instruction or of higher-order questioning is similarly a theoretical assertion. I am therefore not arguing that the preparation of teachers be reduced to the most practical and concrete; rather, using the power of a case literature

> to illuminate both the practical and the theoretical, I argue for development of a case literature whose organization and use will be profoundly and self-consciously theoretical. (p. 10)

Yet Shulman (1992) explicitly warns against referring to a single case method, suggesting that while cases may become canonical, there are many ways of using these cases to arrive at an individual's PCK. This study contributes to the body of cases for education by describing and theorising the ways in which teachers select and use instructional videos. Corresponding with propositions, Shulman (1986) divides cases into three types: prototypes, that exemplify theoretical principles; precedents, that communicate maxims; and parables, which communicate norms. This study questions whether teachers draw on the cases of others when selecting and using instructional videos. Furthermore, it presents rich cases of teacher selection and use of video worthy of theoretical analysis.

2.3.3 Strategic Knowledge

Teaching is necessarily "messy and unpredictable" (Eisner, 2001, p. 378), and therefore neat propositional knowledge will not apply to all circumstances, nor will any single context be identical to another. Shulman (1986) proposes strategic knowledge to deal with the inevitability of situations "where principles collide and no simple solution is possible" (p. 13). The principles of teaching will at times contradict each other and at these points teachers need to make decisions as to the appropriate course of action. In terms of the use of instructional videos, a contradiction might occur when a principle such as *students should be given control over playback* (Mayer & Chandler, 2001; Tabbers & de Koeijer, 2010) conflicts with considerations of classroom management or the value of class discussions. This study examines the knowledge teachers draw on when making such strategic decisions.

2.4 Summary

This chapter has introduced Shulman's framework of teacher knowledge, which will act as an analytic tool to interrogate the kinds of knowledge teachers use when selecting and using instructional videos. Shulman argues that expert teachers draw on a broad range of knowledge types when making pedagogical decisions, informed by both pedagogical scholarship and the wisdom of practice. In his framework, knowledge is understood to exist in the form of propositions, cases, and as strategic knowledge. While wisdom of practice is inherently context-bound, a body of literature exists in terms of how instructional videos can be designed and used to improve student learning outcomes. In particular, research has outlined the way in which particular design elements affect how students process information from instructional videos, and the pedagogical methods that make best uses of the particular affordances of these videos. The next chapter explores literature in both fields.

It is important to note that Shulman described a basis of knowledge which empowered pedagogical reasoning, rather than prescribed particular teaching methods. Indeed, he suggests that two expert teachers facing the same pedagogical situation may justifiably act in different ways, because:

> Knowledge guarantees only freedom, only the flexibility to judge, to weigh alternatives, to reason about both ends and means, and then act while reflecting upon one's actions. Knowledge guarantees only grounded unpredictability, the exercise of

reasoned judgement rather than the display of correct behaviour. (Shulman, 1986, p. 13)

Focusing on the research questions, this thesis will adopt a similar approach, not seeking to prescribe a particular type of video or way of using them, investigating the knowledge base used by teachers engaged in the task of selecting and using instructional videos.

Chapter 3: Effective instructional videos

Shulman considered pedagogical scholarship the “growing body of scholarly literature devoted to understanding the processes of schooling, teaching and learning” (1986, p. 10; see also Section 2.2.3). This chapter explores what in Shulman’s (1987) framework could be considered the pedagogical scholarship of instructional video selection and use. It begins with a discussion of the pedagogical uses of videos described in case study literature including the types of videos used and the delivery methods of these videos.

The chapter then explores the theoretical traditions out of which literature on effective design and use of instructional videos has emerged. Two theories have been particularly influential in this development, Cognitive Load Theory (CLT) and the Cognitive Theory of Multimedia Learning (CTML). More recently, there have been attempts to incorporate elements of motivation and emotion into theories of how learners create knowledge and these theories are outlined. The chapter concludes with a description of the principles for effective design and use of instructional videos emerging from a systematic review of 110 studies on video design conducted for this thesis.

Drawing on Selwyn’s (2008) dichotomy between the state of the art and the state of the actual this chapter describes the state-of-the-art in video selection and use, whereas Chapters 6 and 7 investigate the state of the actual. The literature in this chapter, particularly that related to CLT/CTML, has often been presented as a reliable knowledge base for what teachers should consider when selecting and using instructional videos (Brame, 2016; Cattaneo et al., 2019; Mayer et al., 2020). Comparing what teachers actually consider with regard to instructional videos to the existing literature base is useful in both analytical and theoretical ways.

Analytically, drawing on the existing literature base provides a language by which the tacit can be made explicit (Loughran, 2002) thus allowing examination of links and divergence between and within cases. On a theoretical level, this process allows the participants to talk back to theory (Flyvbjerg, 2006), thus revealing potential implications of this study for the literature into instructional video selection and use more broadly. Therefore, before examining how teachers actually select and use instructional videos, it is important to review what the existing literature suggests as to how teachers should select and use such resources.

3.1 The affordances of instructional videos in education

Instructional videos are increasingly used as a resource in contemporary education. This is particularly true in distance and higher education (Malaga & Koppel, 2017), but also in face to face K-12 (Cunningham et al., 2016) and vocational (Cattaneo et al., 2019) education. This increase in video use has merit, primarily because videos have been shown to achieve similar or higher learning gains than static images such as diagrams, given an effective instructional design (Armstrong et al., 2011; Castro-Alonso et al., 2015; Höffler & Leutner, 2007; Wang & Tseng, 2019). In educational literature the term affordance has been applied to the properties of technologies and “how these properties might be exploited in particular learning and teaching contexts” (Conole & Dyke, 2016, p. 114). The affordances of video go beyond transmission of content, and this section briefly touches on the variety of advantages listed in the literature. For example, tutorial videos have been shown to lead to greater learning gains when compared to live lectures (Craig & Friehs, 2013) and may increase student motivation (Abeysekera & Dawson, 2015). Online video streaming platforms such as YouTube have also been found to provide access to global experts as well as being useful for illustrating abstract or difficult to perceive phenomena (Krauskopf et al., 2012). It is important to acknowledge, however, that the literature outlines reservations regarding the use of videos, and these are explained in section 3.1.7.

Streaming videos have other advantages over printed material, in that they are more flexible (Harrison, 2015), often cheaper, less cumbersome, and increasingly ubiquitous in developed countries (Kizilcec et al., 2015). Kay and Edwards (2012) explain that video lessons usually give students control over pace of learning and have also been shown to lead to improved study habits (see also Murray et al., 2015). Sammet et al. (2015) found that a combination of video and hands-on learning with live animals in secondary biology classes yielded greater learning outcomes than either in isolation, suggesting that video can also be an effective part of a blended learning system (see Section 3.1.1).

This section begins with an outline of the pedagogical uses of instructional videos in the literature that could be applied to mainstream secondary contexts, including blended learning, flipped learning, and in-class use of video. It then proceeds to outline some of the advantages of video proposed in the literature, and principles of video presentation. These are outlined here both to outline the state of the literature, but also to introduce the language used in later chapters to describe the actions and beliefs of the participants in this study. It should be noted that while the literature is quite well developed with regards to higher education, empirical literature in primary and secondary contexts is limited both in number of studies and scope. Because of this reality, while the literature review for this first section draws on 34 studies, only six of these were conducted in secondary contexts and only one (Jones & Cuthrell, 2011) in a primary setting. There is a clear need for more analysis of teacher uses of video in these mainstream schooling contexts. The present research contributes to this literature.

3.1.1 Blended Learning

Blended learning describes a pedagogical approach that blends face to face instruction with online resources, and has been argued by some to lead to greater learning outcomes than face to face learning alone (Smith & Suzuki, 2015). These resources can facilitate activities that are both instructional and social (Harrison, 2015). For example, Craig and Freihs (2013) describe a library course in which students received an introduction via traditional lecture, but were then guided through an online learning space in which videos were interspersed with other learning tasks. Similarly, Smith and Suzuki (2015) described a secondary school mathematics class in which the teacher pre-recorded the lecture component of the class and allowed the students to view these in class, while taking notes. When compared to a class that received instruction directly from the teacher, students in the blended classroom reported receiving more one-on-one time with their teacher and being able to pause the instruction at will.

3.1.2 Flipped Learning

Flipped Learning has its genesis in distance and military education, but has since become increasingly popular in mainstream education (Baggaley, 2015). It is a particular model of blended learning in which the “information transmission component of a traditional face-to face lecture is moved out of class time. In its place are active, collaborative tasks” (Abeysekera & Dawson, 2015, p. 1). Regardless of whether videos are shown at home or in class the defining feature of the method is that direct instruction is achieved through the use of videos, freeing the teacher to engage in other teaching activities.

There has been a rapid growth of research into the efficacy of the flipped classroom model since 2012, as indicated by a search for flipped learning and flipped classroom on the ERIC database in October 2019, which showed that of 531 published articles, none were published before 2012. Both quasi experimental and case studies regularly show gains in learning outcomes for students engaged in flipped classroom environments when compared to traditional classes (Gross et al., 2015; Murray et al., 2015; Schultz et al., 2014; Smith & Suzuki, 2015). A common justification for the use of the flipped learning model is that watching lectures at home increases class time spent in *active* learning (Brame, 2016; Gross et al., 2015), defined as "learning by doing" (Koedinger et al., 2015, p. 111). Interestingly, in their work examining MOOCs, Koedinger et al. (2015) argue that passively watching videos is the opposite of active learning, and as such videos should always be paired with learning activities. Szpunar, Jing, and Schacter (2014) have also shown that passively watching videos can lead to overinflated perceptions of learning on the part of students. This is a potential criticism of the flipped model, and is covered in more detail in Section 3.5.

Abeyesekera and Dawson, (2015) highlight another difficulty of the flipped model when they state that "more troubling [than issues of pedagogy] are issues of student motivation; flipped classroom approaches wager the success of in-class activities on the likelihood of students completing their pre-class assigned work" (p. 2). In other words, students who fail to complete the pre-learning activities are put at a significant disadvantage and may not be able to participate in the class. Shultz et al. (2014) estimated that in a flipped classroom secondary context, this additional time outside of class watching videos resulted in 20-30 minutes of video viewing and note taking at home. There are unanswered questions as to the effect this additional instructional time might have on student performance if the approach was extended to a student's six or seven subjects, as is often the case in secondary school. While flipped learning is a use of video popular in the literature, this study questions whether secondary teachers in mainstream contexts use instructional videos in this way.

3.1.3 In-class use of video

There is surprisingly little in the literature about the use of videos by teachers in face-to-face secondary classrooms. Indeed, the most comprehensive discussion of teacher use of educational videos in K-12 classrooms can be found in a rather dated work by Hobbs (2006), who describes the *non-optimal* uses of videos. Relying on teachers reporting their colleagues' pedagogical use of videos, Hobbs describes the use of videos as rewards, to keep children quiet, to provide teachers with planning time, or to fill time without any critical or educational perspective.

There are, however, a limited number of more positive case studies in the literature. For example, McNeill and Pimentel (2009) described the use of two videos with competing claims on climate change as prompts to scientific argumentation in a high school science class. The videos allowed the teacher to assume the role of discussion facilitator, because the videos had been given the task of information delivery. Holmberg et al. (2018) described the use of speeches by Hollywood stars as demonstrations of argumentation in a German secondary EFL class. The teacher in this case made use of pausing in order to comment live to the class.

This study not only provides a more comprehensive, contemporary understanding of teacher use of instructional videos than is presented in the existing literature, but also reveals an important precursor to this use, namely the process of video selection. In addition, this study reveals the kinds of knowledge and contextual factors impacting this process, thus providing a more nuanced understanding of teacher selection and use of instructional videos.

3.1.4 Pedagogical affordances of videos

The literature investigating teacher and student perspectives outlines a variety of perceived pedagogical affordances that videos can have over other instructional materials. These affordances are outlined in Table 1, highlighting their role as part of what Shulman (1986) described as a teacher's pedagogical "armamentarium" (p. 9), meaning an array of curricular resources. They can broadly be categorised as teacher-focused and student-centred, in that they either assist in the delivery of courses (teaching) in terms of efficiency and flexibility, or improve student learning utility (student-centred). Of course, making distinctions between teaching and learning in education is problematic, but such categories are useful for conceptualising affordances. While Table 1 outlines the affordances of instructional videos in educational contexts, the findings of experimental studies highlighting particular design principles are presented in Section 3.5.

The terminology identified in Table 1 provides language by which the in-class use of instructional videos can be explored, and the knowledge of teachers identified. In answering the research questions in the context of mainstream secondary schooling, this study adds to this literature by identifying key reasons teachers use instructional video, and the role of knowledge and context in mediating that use.

Table 1:

Pedagogical Affordances of Videos in Education

Category	Affordance	Description	References
Teaching focused	Efficiency	Video can efficiently communicate information. In particular, short videos can be more efficient than traditional lectures.	(Hobbs, 2006; Kay, 2012; Moreno & Ortegano-Layne, 2008; Murray et al., 2015)
	Transform class time	By replacing traditional lectures with videos, both teacher time and class time can be freed for other learning activities.	(Abeysekera & Dawson, 2015; Gross et al., 2015; Herala et al., 2017; Murray et al., 2015; Smith & Suzuki, 2015)
	Real life phenomena	Video can present actual footage of events or phenomena that are difficult to replicate in a classroom. Eg. Footage of animals, professional-client interactions, celebrity speakers.	(Holmberg et al., 2018; Karsenti & Collin, 2011; Sammet et al., 2015)
	Promotes discussion	Videos can be used as a provocation to class discussion.	(McNeill & Pimentel, 2009; Murray et al., 2015; Tan & Pearce, 2011)
	Classroom management	Videos can be used as a reward or to keep students quiet. More constructively, they can be used to minimise distractions when played on individual student devices	(Hobbs, 2006; Smith & Suzuki, 2015)
	Topical resources	Streaming services allow teachers to display very current material such as news events.	(Horbal, 2018; Krauskopf et al., 2012)
	Visualising concepts	Videos can provide dynamic visual imagery of hard to understand concepts	(Horbal, 2018; Tan & Pearce, 2011)
Student-centred	Motivation and engagement	Students report being more motivated to learn in courses that include learning from videos.	(Hsin & Cigas, 2013; McNeill & Pimentel, 2009; Murray et al., 2015; Tan & Pearce, 2011)
	Student control	Online video allows student control over playback both in terms of pause play control and time of study	(Giannakos et al., 2016; Harrison, 2015; Holmberg et al., 2018; Kay, 2012; Murray et al., 2015; Smith & Suzuki, 2015)
	Replay	Online video allows students to replay past lessons for revision	(Giannakos et al., 2016; Harrison, 2015; Horbal, 2018; Kay, 2012; Murray et al., 2015)

3.1.5 Videos integrated with other learning activities

Krauskopf et al. (2012), amongst others, argue that the affordances of instructional videos in education "can only be leveraged when teachers combine video technology with appropriate learning goals and tasks" (p. 1194). The experimental literature supporting this notion is described in detail in Section 3.5.6.1. The literature describes a range of such learning activities, including worksheets (Sammet et al., 2015), reflection activities (Schultz et al., 2014), discussion (McNeill & Pimentel, 2009), and online quizzes (Fanguy et al., 2019). Despite the literature on the advantages of completing integrated activities, in a systematic review of literature concerning the use of video podcasts in higher education Kay (2012) found that 95% of papers reported on receptive viewing, in which the student views the video "in a relatively passive manner" (p. 822). Again, despite a comprehensive search of ProQuest, ERIC, Google Scholar, and PsychINFO, using terms focusing on video based learning and multimedia, of the 34 studies uncovered concerning the use of videos in classrooms there is little describing the ways in which secondary teachers in traditional contexts do, or do not, use instructional videos in conjunction with other learning activities. This research addresses this gap in the literature.

3.1.6 Screen Choice

Perhaps the traditional image of watching videos in educational settings is that of the darkened room, with a single screen (TV or projector) on which content is shown to a class of students. In this vision, teachers have control over the playback, and students are passive observers. Hobbs (2006) observed such practices in secondary teachers and judged it a non-optimal approach and recorded the tendency for such viewing episodes to be used to create space for teachers to achieve other aims like lesson planning. Some tertiary educators in Horbal's

(2018) study labelled showing videos in class as “bad pedagogy” (p. 182), suggesting that it was a waste of class time because classes could instead be ‘flipped’ (see Section 3.1.2) where students “watch outside of class and come to the class and spend the entire class period then discussing it” (p. 182).

In contrast, McNeil and Pimentel (2009) explained that very short videos shown on a communal screen could be used in order to prompt discussion amongst students. Holmberg et al. (2018) found that teachers in their study who selected YouTube videos to show in class did so in order to be able to pause and comment live, contextualising the content. Interestingly, after that teacher was given a web-based tool (TubeChop) to select parts of the video and comment over them, she chose instead to share the newly created screencasts with her students to watch individually. This study suggests the choice to show curated videos on a communal screen may at times stem from the need for teacher input to clarify or contextualise the content.

More prevalent in the literature are approaches in which students watch videos on their own devices, usually outside of class as part of a flipped model, or as part of revision (Chen et al., 2015; Lo & Hew, 2017). Some justified this decision on the basis of class time efficiency, in that setting video based instruction outside of class effectively extended the amount of class time available for other learning tasks (Gross et al., 2015; Horbal, 2018). This approach allows students to control the pacing of instruction by “pausing, fast forwarding, slowing down, or replaying” (Smith & Suzuki, 2015, p. 141). Finally, Smith and Suzuki (2015) also reported that the decision to allow students to watch videos on their own devices within the classroom allowed the teacher to be more present to engage with students individually. Importantly, despite being conducted more than a decade apart, both studies that investigated teachers in mainstream secondary schools (Hobbs, 2006; Holmberg et al., 2018) found that prior to any targeted professional learning input, the teachers tended to favour a communal screen.

This study aims to further investigate teacher reasoning behind the choice of screen, and the contextual realities impacting these decisions. It is interesting to note that common themes in literature around screen choice were efficiency (Gross et al., 2015; Hobbs, 2006; Horbal, 2018) relating to both learning and labour; teacher control (Holmberg et al., 2018); and student control (Smith & Suzuki, 2015).

3.1.7 Reservations in learning with videos

Just because instruction can be presented audio-visually, does not necessarily mean it always should be (Leahy & Sweller, 2016). Any suggestion that a digital technology is a priori more effective than static materials risks technocentric reasoning in which technological considerations are preferenced over pedagogy (Harris & Phillips, 2018b). Indeed, Lowe and Schnotz (2014) suggest that there are learning contexts in which static materials can outperform video content, such as when the amount of information required to comprehend the topic is too great to process at the pace a video runs. Clark and Mayer (2016) go as far as to conclude that "a series of static frames should be your default graphic" (p. 84) rather than animation.

Much of the case study literature concerning the use of videos in education is quick to emphasise the benefits of the format. Indeed, as Winslett (2014) deftly expresses, much of the literature "seems to be suffering from an *everything works* syndrome" (p. 499). While it is true that a theme amongst studies in this review was that students often perceive videos as helpful (for example, Chen et al., 2015; Cunningham et al., 2016; Henderson et al., 2015), some students express a preference for live instruction (Craig & Friehs, 2013), especially when videos came to dominate instruction (Kay, 2012). Practical learning activities were also seen as more beneficial than watching videos of the same phenomena in a high school science classroom (Sammet et al., 2015).

In addition to these contexts in which video is not the most preferred medium, a digital divide still exists between developed and developing communities often caused by expensive and substandard internet speeds (Tarus et al., 2015). Even when high quality web connections and hardware are available, native language content is often unavailable to teachers in languages other than English. For example, TedED, a popular producer of high quality short educational videos, produces content almost exclusively in English. Even its Spanish channel simply replaces the English narration with Spanish, leaving English text in the animations unchanged.

Finally, while video resources have great potential educative value, non-educative or suboptimal uses of videos have been routine practice in the past (Hobbs, 2006; Krauskopf et al., 2012). This section has outlined the various benefits of instructional videos, and suggests that they have an important role in education. However, their use should be viewed critically, rather than adopting a "Pollyannaish stance" (Selwyn, 2014, p. 15) which positions educational technology as inherently useful and transformative.

3.2 Types of instructional videos

While the previous section outlined the pedagogical uses of videos, this section explores the videos themselves. This section outlines the types of videos described in literature on instructional video design and use. It begins by outlining the two broad sources of videos in education, those created specifically for the lesson (bespoke) either by the instructor or by a video developer, and those curated by the teacher from a pre-existing course (curated). It concludes with a classification of instructional video styles described in the literature.

3.2.1 Bespoke videos

Bespoke videos are those made specifically for the course or learning task in which they are used. Almost all studies in this review, including the 110 papers in the systematic review described later in this chapter, used bespoke videos. In the studies conducted in educational contexts (as opposed to laboratory settings), these videos often took the form of instructor-made content, such as screencasts (Smith & Suzuki, 2015), lecture captures (Herala et al., 2017), or more complex editing including green screen (Oakley & Sejnowski, 2019). The clear advantage of such videos is that they are tailored to the curriculum and specific student cohorts, and therefore use appropriate terminology and avoid extraneous material. Editing videos heavily so as to leave only what is needed for a learner to understand the main learning goal has been found to lead to greater learning outcomes partly because learners do not have to attend to unnecessary material (Ibrahim et al., 2012; Van der Zee et al., 2017).

One obvious drawback to the use of bespoke videos is their cost, either financially or in terms of teacher labour. Hollands and Tirthali (2015) estimated that one hour of high quality, finished MOOC video costs approximately $US4300. Instructor-created video can take anywhere from minutes to up to 40-60 hours of work to produce a five minute clip (Langworthy, 2017) and rarely earns an educator any extra remuneration. Harrison (2015) found that the production and hosting of videos requires “more demanding technical skills and pedagogical understanding” (p. 185) on the part of teachers than is often anticipated and therefore can become burdensome.

3.2.2 Curated video

Curating refers to the purposeful selection of pre-existing video content and its presentation to students to achieve learning goals. The provision of video on physical media such as DVD and VHS by libraries at educational institutions is being phased out and is rapidly being replaced by online streaming media (Hutchinson & Farrelly, 2016). This claim is supported by the literature reviewed, which revealed only one study published since 2010 used physical media (Walstad et al., 2010). Previous studies in a range of contexts (Holmberg et al., 2018; Krauskopf et al., 2012; McNeill & Pimentel, 2009; Schmidt, 2015; Tan & Pearce, 2011) argue that teachers are increasingly turning first to large scale platforms like YouTube to curate instructional videos yet do not explain how teachers select from amongst the available resources. Third party commercial educational providers like ClickView (a popular Australian educational provider) allow instructors to manipulate video, incorporating activities and learning prompts (Herala et al., 2017). Despite the self-proclaimed popularity of these providers, nothing was found in the literature that suggests when and why these services are used in secondary schools.

The first advantage of curating videos is, obviously, that the teacher is not required to create the content. However, there is significant labour involved in searching and selecting these videos purposefully, and this labour relies on a teacher's PCK (Holmberg et al., 2018), meaning less experienced teachers may not be in a position to effectively curate video content without guidance. A further advantage of pre-existing video is that they can often be of a higher production quality than a teacher has the resources to create (Horbal, 2018; McNeill & Pimentel, 2009). Despite consistent suggestions in the literature that teachers regularly curate online videos for use by students, these is a lack of research about how secondary teachers actually select those videos and the specific knowledge they draw on when doing so. This research specifically addresses this gap in the literature.

3.2.3 A classification of instructional video styles

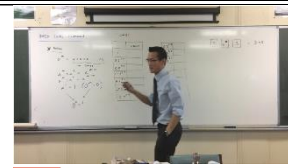
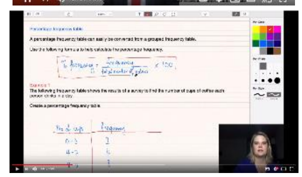
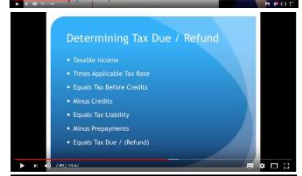
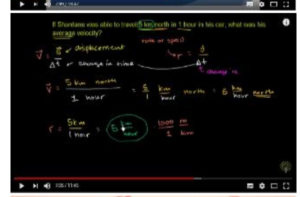
While this thesis concerns instructional videos, meaning videos concerned with factual, conceptual, or procedural knowledge, it is clear that instructional video is "not a genre in and of itself, but rather a meta-genre, incorporating a range of production styles, techniques and conventions" (Winslett, 2014, p. 489). In order to discuss the videos that teachers select and use clear nomenclature is required so readers can determine the type of videos in question, both pedagogically and in terms of production format. Ploetzner and Lowe (2012) suggest that "there is still no systematic account of the main differences" (p. 781) amongst animation and video types. Too often in the papers reviewed for this study videos were reported as *a short lecture* or *an animation* without any further illumination as to how the information was presented. In order to ensure a common language with case study participants, and also to allow comparisons or meta-analyses of existing research, it is important to enumerate and describe the main sub-genres of instructional videos. The reader may also benefit from being able to visualise the types of videos being discussed. A literature search was completed using the terms *video classification* and *video taxonomy*. The resulting classification table synthesises Chen and Wu's (2015) descriptions of video lecture styles; Chorianopoulos' (2018) taxonomy of asynchronous instructional videos; the review of video and online learning by Hansch et al. (2015); Guo et al.'s (2014) descriptions of MOOC videos; descriptions of eight typical online learning videos used in an experimental comparison by Choe et al. (2019); Santos-Espino et al.'s (2016) descriptions of MOOC video lessons; Winslett's (2014) review of video use in higher education; and Ten Hove and van der Meij's (2015) analysis of popular YouTube videos. The worked example style was described by Poquet et al. (2018) in their literature review of tertiary video learning.

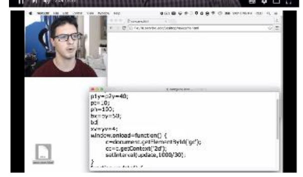
While the existing classifications and taxonomies included in this literature review described some video styles well, they either omitted some popular styles or only described videos made for specific higher education contexts (Chen & Wu, 2015; Choe et al., 2019; Guo et al., 2014; Poquet et al., 2018; Winslett, 2014). For example, Chorianopoulos (2018) mentioned TEDed as a leading provider of instructional videos, but chose not to represent their narrated animation style as a unique type in the resulting taxonomy. Therefore, the classification included here is informed not only by the literature, but also by the data gathered in the course of this project (see Chapters 5 and 6). Previous classifications and taxonomies were coded and compared using the constant comparative method (Boeije, 2002), and the most commonly used name for each video type was adopted. A new style was included if there was a pedagogical or structural difference to all previous video styles. Where the titles were long and considered cumbersome, an abbreviated title was conceived. Appendix A shows the variety of titles given to each video type across the literature and highlights the necessity for a clear nomenclature.

Table 2 shows the resulting classification list (out of the literature review outlined in Appendix A) of 19 video types that will be used for this thesis. Video styles are named, coded, and described. Each video style is also accompanied by a still image from a typical example available on YouTube at the time of writing. The reader is encouraged to search the name of sample videos on the YouTube platform in order to view the video in its entirety if the description remains unclear. Table 2 clarifies the classifications which determine the nomenclature adopted in the analysis chapters when discussing teacher selection and use of particular videos.

Table 2:

Classification of Instructional Video Styles

Name	Code	Description	Example title	Example Screenshot
Lecture capture	LC	Instructor is filmed delivering a traditional lecture with or without live audience	Eddie Woo: What is 0 to the power of 0?	
Picture in picture superimposed	PIP	Image of instructor is superimposed over PowerPoint slides	Open Tuition: Introduction to the Financial Accounting Exam	
Screencast	SC	Screencast of instructor's screen with or without image of instructor's face in separate box.	Aimee Shackleton: Percentage frequency tables	
Voice over slides	VS	Instructor's voice narrates over PowerPoint slides	Gordon Hensley: Introduction to Taxes Video Lecture 1	
Narrated Tablet (Khan Style)	NT	Instructor narrates while manipulating a virtual tablet by drawing and using the cursor	Khan Academy: Introduction to vectors and scalars	
Animated declarative	AN	Instructor narrates over bespoke animations	TED-Ed: What happens when you have a concussion?	
Live action how-to	LHT	Narrated live demonstration of a particular skill/process	Teachinglearninguoit: How to light a Bunsen burner	
Whiteboard animation	WB	Instructor narrates while a (real or simulated) hand draws on a white background	Gates Foundation: Bill Gates: Vaccines save lives	

Lightboard lesson	LB	Instructor delivers a lesson facing the camera, while writing on a clear glass surface	Joel Speranza: Using Pascal's triangle to calculate combinations	
Documentary style	DOC	Live action to camera narrated in a traditional documentary narrative style	Vox: Fencing explained	
Interview/Dialogue	ID	Host interviews experts or ordinary people	Capture Your Flag: Simon Sinek on Learning How Not to Manage People	
Worked Example	WE	Expert actually performing a process, such as tutorials, code-along examples	Gamkedo: Coding an HTML5 Canvas Game with JS in 5 min 30 sec	
Infotainment Combined	COM	Combination of animation and live instructor capture in an entertaining, light hearted manner	Crash Course: Water - Liquid Awesome: Crash Course Biology #2	
Dramatisation	DRA	Dramatic recreation of process or context intended to model a concept	NSW volunteering: Listening skills for conflict resolution	
Advertisement	AD	Videos that are designed to promote or explain a product to potential consumers.	Gamechangers: Uber Case Study	
Memory Aid	MA	Songs, Rhymes, or Poems to help students memorise or learn a concept	Lauren Misretta: Lab Safety Rap (Teachers)	
Live Capture	LCR	Live footage of an event or demonstration	Optical Data Corp: Alkali metals in water	
Talking Head	TH	Presenter in close-up talks directly to camera	Little Art Talks: The Meaning of Appropriation	

Animated how-to	AHT	Narrated animated demonstration of a particular skill/process	Integral Fire Protection: How to use a fire extinguisher	

3.3 Cognitive theories of instructional video design (CLT and CTML)

This section moves to a discussion of the theoretical traditions out of which principles for effective design of videos have emerged, namely CLT and CTML. In the data analysis chapters (Chapters 6 and 7), these theories will be used as a way of making sense of teacher knowledge concerning the design of instructional videos when that knowledge is expressed as messy wisdom of practice, helping to make explicit what is tacit (Loughran et al., 2004). A concurrent comparison between the state of the actual (as revealed in this study) and the literature purporting to present an instructional video design state of the art may reveal consequence for both theory and teacher practice. For example, a finding that teachers act on knowledge or contextual factors that contradict the principles in this section may point to limitations of CLT/CTML. Equally, findings that point to a lack of knowledge of instructional design principles may have implications for initial teacher training programs and professional development. In order for the findings of this study to speak to the literature on the selection and use of instructional videos more broadly, it is first necessary to review that literature.

In a systematic review of 110 articles on video design principles outlined in Section 3.5, two related theories emerged as particularly influential. Cognitive Load Theory (CLT) and the Cognitive Theory of Multimedia Learning (CTML) are theories of human cognitive architecture that aim to explain how humans process and store biologically secondary information (as opposed to information learnt innately like a first language). Both theories posit that human cognitive architecture is based around a very limited working memory, and a much larger long-term memory. It is these limits of learner cognition that underpin the instructional design principles emerging from CLT and CTML. Paas and Sweller (2014) suggest that without a working knowledge of the way humans process information, “the effectiveness of instructional design is likely to be random” (p. 27). This section explains these two theories as a precursor to understanding the video design principles emerging from the literature.

Developed in the late 1980s and 90s (Sweller et al., 1998), CLT aims to explain “how the information processing load induced by learning tasks can affect students’ ability to process new information and to construct knowledge in long-term memory” (Sweller et al., 2019). The systematic review of the literature in Section 3.5 reveals that CLT has been influential in instructional video design literature as it outlines a model of cognitive architecture that seeks to quantify and optimise the capabilities of the human mind when dealing with novel information, a key aim of such learning materials. In CLT, learning is defined as change in long-term memory (Paas & Sweller, 2014) or the construction of schemas “in working memory to be held in long term memory” (Leahy & Sweller, 2016, p. 108).

CTML emerged out of an attempt to apply CLT to the specific task of designing multimedia, defined as learning from words and pictures (Mayer, 2014a; Mayer & Moreno, 1998). While CTML emerged from CLT, and they share many common features, an important difference revolves around the role of the learner. The active processing assumption in CTML describes the role learners play in the “construction of a coherent mental representation” (Mayer, 2014b, p. 50). Furthermore, learning is defined as the creation of such working mental models in long term memory (Mayer, 2014), a definition more reconcilable with constructivist views of knowledge, and with teacher statements about students *understanding*, rather than *remembering*. Table 3 outlines the similarities and differences between the two theories. While for the sake of brevity in this thesis, the two theories will be treated together, for a more detailed account of the divergence between the two, the reader is encouraged to consult the *Cambridge Handbook of Multimedia* (Mayer, 2014a).

The following sections outline the human cognitive architecture suggested by CLT/CTML. It is this structure that gives rise to the design principles later in this chapter, which will be used as an analytic device to make sense of teacher knowledge of video design in Chapters 6 and 7. Moreover, cognitive load, the limitations of working memory, prior knowledge, and information processing may be useful constructs with which to describe the tacit wisdom of practice knowledge of teachers concerning student learning from instructional videos.

Table 3:

Comparison of Terminology in CLT and CTML

	Cognitive Load Theory (CLT)	**Cognitive theory of multimedia learning (CTML)**
Concept of learning	Change in long-term memory	Active construction of working mental models in long term memory
Basic demands of a learning task	Intrinsic Load	Essential processing
Demand imposed by poor design	Extraneous Load	Extraneous Processing
Amount of cognitive capacity devoted to creating meaning/learning	Germane load (contested)	Germane processing

3.3.1 The limitations of memory

Both CTML and CLT make a distinction between *long term memory*, where large amounts of information is stored “on a semi-permanent basis” (De Jong, 2010, p. 105) and short term memory in which small amounts of information are stored for a very limited time, around 20-30 seconds (Feldon et al., 2019), depending on “how much it is rehearsed, and how much someone already knows about the domain in which the information will be situated” (Reedy, 2015, p. 356). This short term memory is usually referred to as *working memory* in CLT “to emphasise that this component of memory is responsible for the processing of information” (De Jong, 2010, p. 105) . Working memory is limited to around 4±1 interacting novel elements at one time, known as the limited capacity assumption in CTML (Mayer, 2014b). However, working memory is only limited when working with novel information, and long term memory is theorised to be limitless (Sweller et al., 1998). As such, vast amounts of information can be retrieved from long term memory to help solve problems following appropriate signals from the environment. In a recent interview, CLT pioneer John Sweller explained that this view of memory was central to the resulting instructional design principles advocated in CLT:

> The instructional control of cognitive load provides the ultimate raison d’être of CLT. The theory is concerned with procedures to reduce the burden on working memory when dealing with complex (high element interactivity) novel information to facilitate the transfer of knowledge to long-term memory. The success of the theory should be gaged by the extent to which it meets this aim. (Mavilidi & Zhong, 2019, p. 7)

3.3.2 Cognitive load

Cognitive load itself is the mental effort a learner expends, drawing from a human cognitive resource bank of limited working memory and unlimited long-term memory (Kirschner et al., 2011). This cognitive load is theorised to consist of intrinsic, extraneous, and germane load. In CTML, the term *load* is changed to processing, recognising the active role learners play in constructing knowledge.

3.3.2.1 Intrinsic load/essential processing

Intrinsic cognitive load (or essential processing) refers to the innate difficulty of a task for a particular learner. This is determined by the number of novel elements, meaning the ideas or parts of a learning task, and the level of interactivity between the elements (De Jong, 2010, p. 106). Given working memory is limited to around 4±1 novel elements interacting at one time but long term memory is unlimited, the more elements a learner holds in long term memory schemas, the easier the learning task will be (Leahy & Sweller, 2016). Therefore, a task will have a base level, or intrinsic load, affected by the complexity of the task, the student's prior knowledge, and their working memory capacity (De Jong, 2010; Ginns, 2005; Kirschner et al., 2011). For example, a young child learning to read will usually start with short words, with less letters to 'put together' in her mind. Kalyuga (2011) suggests that the task of managing intrinsic load "requires selecting tasks that are not too complex relative to learner levels of expertise but, on the other hand, not so simple as to no longer be sufficiently challenging and motivating within the available cognitive capacity" (p. 3).

3.3.2.2 Extraneous load

Extraneous cognitive load is the additional load imposed by "instructional procedures that are less than optimal" (Sweller, 2010, p. 125) and refers to any cognitive effort that that "does not support the instructional goal and is caused by poor instructional design" (Mayer, 2014b, p. 59). A simple example is that the inclusion of unnecessary pictures in an instructional design may divert cognitive resources to interpreting those images rather than the real learning goal (Park et al., 2011). Many of the design principles emerging out of CLT deal with the reduction of extraneous load.

3.3.2.3 Germane load/generative processing

Germane load refers to the working memory resources of the learner that are directed to intrinsic rather than extraneous cognitive load (Paas & Sweller, 2014). In short, germane load is the amount of mental effort the student dedicates to learning the material. The construct of germane load is one point on which there is not only division within CLT theorists, but on which CLT and CTML diverge. Paas and Sweller (2014) differentiate between intrinsic load, as the innate difficulty of the task, taking into account the number and interactivity of the elements, and germane load as the final amount of working memory dedicated to learning the task. This means germane load is varied by the level of motivation shown by a student. In other words, while the cognitive load of a task is defined as “the working memory resources required for processing all the involved elements” (Kalyuga, 2011, p. 14), germane load describes the actual attention given to that task.

CTML conceptualises germane load as generative processing and it is this conception that is drawn upon throughout this thesis. Mayer (2014) suggests that there is a difference between rote learning, which results in good recall performance, and generative processing, which requires the fostering of working mental models, integrated with prior learning. Ultimately the role of instructional videos is to encourage the development of working schemas, and as such videos should be designed in such a way as to encourage students to successfully integrate new material into working mental models. The principles attributed to generative processing have been shown to facilitate this, and as such the theoretical divergence on this point, while interesting, does not undermine the aims of this research project.

CLT/CTML have given rise to a number of principles of instructional video design (see Section 3.5). As such, they can be used to make sense of the language teachers use when describing instructional video design (see Chapter 6). Furthermore, while the principles derived from research into CLT/CTML have often been used uncritically as a basis for video design (see Brame, 2016), this research speaks back to the theories by considering contextual elements particular to classrooms, yet controlled for in the experimental designs that are preferenced (Mayer, 2014a) in CLT/CTML literature.

3.4 Affective theories of video design

The two theories discussed in this chapter so far focus on the cognitive aspects of human information processing, such as “selecting relevant information, mentally organising the material into a coherent organization, and integrating it with relevant prior knowledge activated from long-term memory” (Mayer, 2014c). More recently (see Plass & Kaplan, 2016) some theorists have suggested that however useful these theories are in describing information processing, they do not adequately explore the effect that motivational and affective factors can have on learning and can therefore been described as “cold cognition” (Park, Flowerday, et al., 2015, p. 267). Winslett (2014) is critical of the minor role affect plays in literature on instructional video design suggesting that it is affect, or engagement, “that motivates students to undertake learning activities that are challenging and time-consuming with outcomes that may not be immediately apparent” (p. 499). Mayer himself has acknowledged that “the role of motivation is somewhat underspecified in CTML” (Mayer & Estrella, 2014, p. 14) and Feldon et al. (2019) conclude that most CLT research lacks “consideration of the interactions between cognitive load and motivation or emotion during learning” (p. 1).

In the same way in which the terminology of CLT/CTML may be a useful analytic device to make sense of teacher knowledge around student learning and video design, this section offers a theoretical framework for “something that practitioners in education have known for millennia” (Plass & Kaplan, 2016, p. 131), that learning is mediated through affect and emotion. Plass and Kaplan’s (2016) integrated cognitive affective model of learning with multimedia (ICALM) is an attempt to integrate previous work on affect with CTML to arrive at a framework that considers the interaction of cognition and affect. It builds on Pekrun’s (2006) control value theory of achievement emotions (CVT) and Moreno and Mayer’s (2007) cognitive affective theory of learning with multimedia (CATLM). These theories may be helpful in analysing and making cross case comparisons around what Shulman (1987) called teacher knowledge of learners and their characteristics.

3.4.1 A caveat in affective design

An important consideration when discussing the role of affect is that liking and learning are not always positively correlated (Castro-Alonso et al., 2019; Craig & Friehs, 2013). For instance, Muller, Bewes, et al. (2008) found that students learned more about physics from videos they deemed confusing than from those they described as clear. Rey and Steib (2013) found that even though Austrian students learned more effectively from videos recorded in their own dialect, they reported more interest in those recorded in standard German. It is important, therefore, to note that simply creating videos that engender positive affect or self-reported learning gains (see Wijnker et al., 2018) does not necessarily relate to greater learning outcomes.

In answering the research questions, it will be interesting to consider the extent to which teachers consider how much the students like the videos selected.

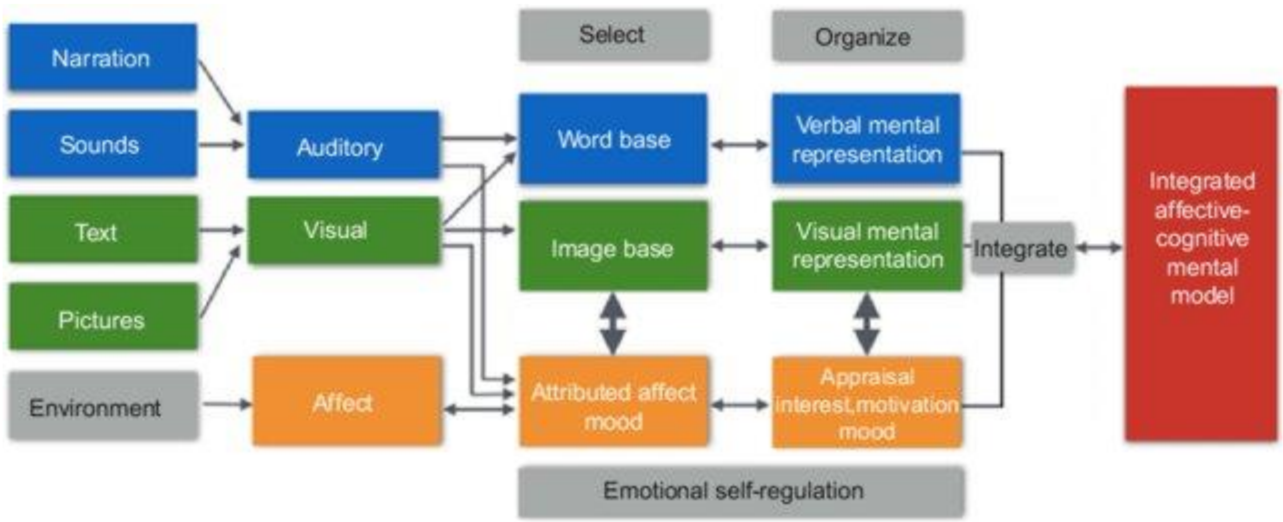
3.4.2 Integrated theoretical approaches

The criticism that cognitivist theories have denied the importance of affect and emotion has led some to develop theories that integrate cognitive processing with knowledge about emotional regulation and the role of affect. Building on the assumptions of CLT and CTML, Moreno (2006) proposed a Cognitive-Affective Theory of Learning with Media (CATLM). The CATLM put more emphasis on active meaning making in the learning process, recognising both the role of motivation factors in the media, and the metacognitive skills of the learner (Moreno & Mayer, 2007). Unfortunately, Moreno's illness and eventual death in 2010 interrupted work on this theory and little development has occurred since.

A more developed model of cognitive-affective processing is the integrated cognitive affective model of learning with multimedia, or the ICALM (Plass & Kaplan, 2016). This model builds on Mayer's and Moreno's CTML (2007) by integrating Russell's (2003) notions of core and attributed affect, and Izard's (2009) ideas about emotional schemas. The resulting model provides a robust framework to discuss the interactions between affect and cognition when learning from multimedia. Figure 2 shows the ICALM proposed by Plass and Kaplan (2016, p. 150).

Figure 2:

Integrated Cognitive Affective Model of Learning with Multimedia (from Plass & Kaplan, 2016, p. 150)



The blue and green boxes represent the audio and visual elements of the multimedia presentation such as an instructional video. These elements are integrated into a mental model when students attend to the elements via a process of selecting, organising, and integrating. To this extent, the model is identical to CTML. To this existing model, Plass and Kaplan add the emotional elements of core and attributed affect, appraisal, interest, and motivation from the work of Russell (2003) and Izard (2009).

Viewing multimedia representations, such as videos, induces affective responses, such as joy, interest, boredom, or some fluctuation between these emotional prototypes (Russell, 2003) which are labelled core affect. Some of these emotions may be induced by the multimedia itself in which case they are labelled as attributed affect. An example of this attributed affect in videos was described by Um et al. (2011), who showed that amusing cartoons can induce heightened but brief feelings of core positive affect, and that colourful, anthropomorphic design of graphics can induce more lasting positive core affect. On the other hand, some emotions exist unattributed by the media, and this is labelled mood. As shown in Figure 2, these emotions are not theorised to exist in isolation, as the mood of a learner may influence the way in which they approach viewing a multimedia representation, and conversely the multimedia may alter their mood. The elements of visual and auditory information a learner attends to may influence affect, and core affect may also lead to certain elements receiving more attention. For example, a student in an angry mood may attend to different elements of a video than a student in a hopeful mood. Elements of the learning environment prior to engaging with a multimedia representation may have a role in establishing this core affect.

Just as working memory represents the limits of cognitive processing ability in CTML/CLT, so too emotional self-regulation represents the limits of affective processing capability in the ICALM. In the same way inefficient cognitive processing, in the form of extraneous load, reduces the efficiency of instructional design, so too does inefficient or extraneous affective processing. Emotions that distract a learner from the central learning goal are deleterious, while cognitive affective states conducive to learning should be encouraged in instructional design. An example of deleterious affective processing cited by Plass and Kaplan (2016) is that of the *stereotype effect*, in which pre-existing negative stereotypes of groups such as African-Americans, women, or White males "result in emotional responses that interfere with cognitive processing" (p. 151). At the same time, if intensity of emotion is under-stimulated, learning may be compromised. For example, if enjoyment, joy, or hope are not induced by the multimedia, or experienced as mood, a learner may lack motivation to learn. Therefore, as Plass and Kaplan (2016) summarise:

> The main thesis of this model is that affective processes are intertwined with, and inseparable from, cognitive processes, and that the cognitive-

> affective processing of multimedia stimuli involves affective processes that make demands on cognitive resources. (p. 150)

This model shows the potential to explain the processing of instructional videos more comprehensively than the cold cognitive theories of CLT/CTML. One possible criticism of the model is that it only provides for interactions between humans and computers, rather than the human to human interaction common in mainstream classrooms.

This section shows that work has begun to progress cognitive theories beyond cold cognition, incorporating affective factors. Like CLT/CTML (see Section 3.3), the ICALM is engaged to provide a theoretical language to explain teacher knowledge about the ways in which students process instructional videos. In particular, the ICALM is a powerful way of theorising the ways in which teachers perceive the attributed affect of *cool* and *corny* videos (see Section 6.1.2).

3.5 Principles of effective instructional video design - a systematic review

To answer the main research question concerning the selection of instructional videos, this study questions the design features that teachers consider effective. In other words, when searching for video content to use in their practice what design elements would make a teacher select, or reject, a video? The second focus of the main research question concerns the way these instructional videos are used. This use may include how the videos are shared or displayed, the integration of videos into learning sequences, and the intended learning outcomes. In reporting on a systematic review of the literature concerning effective instructional video design and use principles, this section of the thesis establishes what could be considered the existing state-of-the-art (Selwyn, 2008).

These principles will be used to develop an a priori coding scheme for teacher considerations of video design and use reported in this study. Furthermore, comparison between the reasoning of teachers in real contexts and the literature largely derived from experimental designs allows this study to speak back to the literature more broadly. While these principles present an important lens through which instructional videos design may be evaluated, teachers may surface additional considerations as yet unacknowledged or underplayed in the literature.

In the fields of CLT and CTML, certain instructional design principles (Höffler & Leutner, 2007; Mayer & Fiorella, 2014) have been theorised and tested to help manage cognitive processing when learning from multimedia and therefore contribute to an easier learning experience, especially for low proficiency learners (De Jong, 2010). Ultimately, "poorly constructed materials" (Ayres, 2015, p. 632) that do not take into account cognitive load are theorised to lead to inferior learning outcomes in experimental conditions. These design principles have been applied successfully across a range of experimental learning environments, including static textbook design (Mayer, 2014), PowerPoint slide design (Issa et al., 2011) and simulations in the field of medicine (Reedy, 2015). It is important to note, however, that despite these principles being broadly accepted and often uncritically applied to video design (for example, Brame, 2016; Carmichael et al., 2018; Mayer et al., 2020), there is a significant corpus of literature describing experiments that have failed to replicate many of the principles (Debuse et al., 2009).

This section isolates and analyses the literature that specifically deals with instructional videos rather than other types of media. Working on the assumption that various media types may benefit from different design principles due to the existence of boundary conditions (Leahy & Sweller, 2016; Lee & Mayer, 2018), a literature search was conducted to find work that compared the designs of instructional videos in experimental, quasi-experimental, and case study settings. Principles that are not supported in literature using instructional videos as the multimedia format, even if they have been accepted for use in other instructional media, have been excluded from this discussion. As such, this review departs from other lists of multimedia design principles such as Mayer's (2014b) in that it excludes some principles that apply to other media types but not videos, and adds new principles established and supported in the literature. A table outlining the publications included in this systematic review and the results of coding is included as Appendix B.

3.5.1 Review method

This section presents the method adopted to conduct a systematic review of video design principles in 110 peer reviewed publications, employing qualitative coding of video design principles in research findings and quantitative counting of codes (Rosenberg & Koehler, 2015b). It followed the sampling and assessment processes proposed by Petticrew and Roberts (2008) to determine inclusion criteria and as a guide to analysis. This systematic review drew on research stemming from experimental, quasi-experimental, case study, and data analysis methods to enumerate and critically evaluate design principles for instructional videos.

This systematic review was conducted using the inclusion and exclusion criteria outlined in Table 4. For a study to be included it needed to satisfy all of the inclusion criteria without violating any of the exclusion criteria.

Table 4:

Inclusion and Exclusion Criteria for Systematic Review

Inclusion Criteria	Exclusion Criteria
Instructional materials included videos or dynamic (rather than static) animations	VR videos, static media only, video conferencing
Educational context (such as K-12, tertiary, vocational, professional)	Early learning, EFL or language learning, or special education contexts
Original, peer-reviewed research papers written in English	Meta analyses and reviews
Paper focused on learning from videos	
Reported empirical results comparing video designs	

3.5.2 Search Strategy

In April 2019, 21 search strings based on existing design principles and general terms relating to instructional videos were entered into the ProQuest, ERIC, and PsychINFO databases (see Appendix C for a full list of these terms). In addition, articles were identified through a broad-based exploratory search. When search terms were not obvious due to a lack of accepted terminology, papers from the broad-based search and other seminal works were scanned for key terms. This very broad search method and the complex nature of the search strings were required due to the lack of accepted nomenclature in the field, and the tendency for searches using the term video to return a large number of results concerning video games.

These searches returned 1218 papers and conference proceedings. After reviewing titles and abstracts, 982 were excluded due to: the context of the study being other than instructional videos (498); a focus on video games (44); an EFL focus (28); printed in a language other than English (3); and duplicates (408). This left 236 full text papers to review.

During a close analysis of these full texts, a further 133 were excluded due to a lack of empirical findings, such as proposals or theory papers (18); methodologies that did not compare video designs (30); non-video multimedia type (75); and an inability to source full text copies (2). During this process, 8 additional papers were identified in the references of the included articles. This led to 120 papers that were coded using NVivo software (Version 12.2). Finally, during this coding process, 10 further papers were excluded that did not compare video designs. This brought the total to 110 papers that contribute to the results of this review. The following sections outline the principles that were found to have broad support in the literature.

3.5.3 Extraneous Processing Principles

Extraneous processing principles focus on maintaining student attention on the main learning goal, and as such minimising distractions of all types (visual, audio and conceptual) is key. Four principles (coherence, signalling, video length reduction, and segmenting, summarised in Table 5) have been isolated as consistently leading to greater learning gains in a range of experiments and case study contexts. Each principle is briefly explained in the sections following Table 5. Importantly for readers well acquainted with the literature on multimedia design, Mayer and Fiorella (2014) suggest that *redundancy*, which describes displaying information concurrently in two forms, like subtitles and narration, impedes learning. While this has been displayed in static media, this review found a lack of evidence for the redundancy principle in literature using instructional videos as the learning medium, and as such it has been excluded.

Table 5:

Extraneous Processing Principles for Instructional Video Design

Principle	Design Implications
Coherence	Only instructional material directly related to the key learning goal should be included.
Signalling	Important information should be highlighted to learners
Video Length Reduction	Shorter videos are more effective than long ones
Segmenting	Videos should be split into shorter segments

3.5.3.1 Coherence

The coherency principle describes the positive effect on learning when multimedia presentations include only essential material, excluding anything extraneous to the main learning goal (Mayer & Fiorella, 2014). At times, the coherency principle has been studied in its negative, as the seductive details effect (Ozdemir & Doolittle, 2015). Seductive details are those elements of a multimedia presentation that are included to increase the entertainment value or emotional engagement, but distract from the essential message.

In essence, the coherency principle calls on instructional video designers to edit or weed (Ibrahim et al., 2012) heavily so as to leave only what is needed for a learner to understand the main learning goal (see also Van der Zee et al., 2017). This assists learners in the process of selecting the important information, a key stage in constructing mental models (Mayer, 2014b). If only important information is included, this process of selecting is made much easier, freeing cognitive capacity for generative processing. Mayer and Fiorella (2014) offer the example of a presentation on lightning formation that includes impressive video segments of lightning storms, and a seemingly interesting tale of a football player whose boots were blown off by a lightning strike. While these details are riveting, they do not add to a learner's understanding of lightning formation and therefore impose extraneous cognitive load. Inclusion of seductive details can lead to learners building mental models centring on the unimportant details, rather than the essential learning goal (see Shen et al., 2006). In this review, eight of the ten studies that tested coherency found that coherent videos resulted in higher learning gains than those including extraneous materials.

Some authors have suggested that in real world learning scenarios seductive details may raise interest, offsetting the coherence principle (Muller, Lee, et al., 2008; Sitzmann & Johnson, 2014). Indeed, recent research has attempted to find ways of reducing the negative learning effect of including entertaining but extraneous material (Yue & Bjork, 2017). Given this research has so far been limited, and the vast majority of studies using videos as instructional media have shown weeding out extraneous material to lead to learning efficiency, this remains the most reliable design advice.

3.5.3.2 Signalling

The signalling principle (Ibrahim, 2012; Mautone & Mayer, 2001; Mayer & Fiorella, 2014), sometimes referred to as the attention guiding principle or cueing principle (J. J. Lin et al., 2016; Xie et al., 2017), refers to the positive effect on learning achieved when the learner's attention is directed towards the most essential elements of a multimedia presentation. This can be achieved using gestures by the presenter, labels, emphasis, animation or listing important points before a section of instruction has been shown (Fiorella & Mayer, 2016, experiment 2; Mautone & Mayer, 2001, experiment 3). Signalling has been shown to be particularly effective for low prior knowledge, or low spatial intelligence learners (L. Lin et al., 2016), or when dealing with highly complex materials. In this review, while 11 of the 14 studies replicated the effect of signalling, six failed to do so (some papers report on multiple experiments, or with multiple measures, hence the total of effects being greater than the total number of papers). This discrepancy has much to do with the reality that signalling describes a wide range of design interventions and there is room for research comparing signalling types.

The clearest example of the attention guiding principle might be the use of a bright arrow (L. Lin et al., 2016) or finger (Beege et al., 2020; Li et al., 2019) that points at the part of an animation being discussed by a narrating voice-over, moving as the narration shifts to a different aspect of the animation. Alternatively, Jamet et al. (2008) showed that sequentially revealing regions of the brain as a narrator explained their function increased retention of the information when compared to narrating a static image. Similarly, Lowe and Schnotz (2014) describe a composition approach which centres around revealing “relation sets” (p. 533) such as two pieces of a piano hammer function before revealing another set, eventually joining the sets together to reveal the whole mechanism. In doing so, the learner is guided to pay attention to inconspicuous but important relationships first, without being distracted (and possibly overloaded) by the other elements of the mechanism. Regardless of what device is used, L. Lin et al. (2016) suggest that cues should be applied “sparingly” (p. 809), such as by animating only one arrow at a time rather than many, because otherwise learners may not know “where they should pay special attention” (p. 809). This guidance of attention can encourage deeper scrutiny of an image by a learner by directing them to details and in turn alleviate the reality that students often consider a brief glance enough to grasp the meaning of an image (Rasch & Schnotz, 2009).

3.5.3.3 Video length reduction

All ten papers in this review that studied the effect of video length concluded that short videos either led to higher learning gains or a significantly higher student engagement rate (measured in view rate or retention). Indeed, Guo et al. (2014) suggest that of all variables measured, video length was “by far the most significant indicator of engagement” (Findings, paragraph 1). While the length of the video is important, an additional benefit of the process of editing down content is that videos are made concise, avoiding redundant details (Hansch et al., 2015). A limitation of the literature is that all ten of the studies found for this review were completed in tertiary or adult learning environments, and as far as could be determined there are no studies into the optimal video length for secondary students. Because of this lack of research, theoretical assumptions, and the findings from tertiary studies form the basis of the recommendations in this section.

The precise optimal length for a video is contested. By monitoring blinking patterns using eye-tracking technology, Pi and Hong (2016) found that when viewing lecture recordings, undergraduate students’ mental fatigue increased at the 10 minute mark. Under experimental conditions in which turning off the video was not an option, students “refreshed their minds” (p. 141) and lasted 10 more minutes before hitting peak mental fatigue. In a more organic context, across two papers, Guo et al. (2014) analysed almost 40 million video watching interactions of 127,839 students in four MOOC courses and found that videos of length greater than five minutes elicit significantly higher dropout rates. Kim et al. (2014) found that students not only drop out of longer videos at a much higher rate as interest wanes (53% of five-minute videos vs. 71% of twenty-minute videos), but a significantly higher proportion of students instantly drop out of 20-minute videos (47% in the first 3% of the video) than 5-minute videos (35% in first 3% of video). This means that even if a 20-minute video is produced well, a proportion of students will switch it off simply due to the length. Similarly, undergraduate students have been found to watch short course videos twice as often as long videos (Cooper & Higgins, 2015; Herala et al., 2017). Brame (2016) accurately summarises the importance of this effect by saying that “the idea is simple: if students do not watch videos, they cannot learn from them” (p. 4). Ultimately, Guo, et al. (2014) recommend keeping videos to under six minutes, which is a figure also recommended by Brame (2016) and Kulgemeyer (2018).

The likelihood of students completing post video learning activities also drops in accordance with video length, with videos under three minutes having the highest interaction level in MOOC contexts (Guo et al., 2014). Harrison’s (2015) phenomenological study also supported 5-10 minutes as an optimal length, with 53.8% of 116 pre-service teachers suggesting this as the preferred length of an instructional video (19.3% preferred even shorter videos of 1-4 minutes). Interestingly, Harrison suggests this preference for shorter videos may be because of social factors (such as the need to consume videos on work-breaks) rather than cognitive limitations. Similarly, Bobrow et al. (2011) found that while a one minute CPR training video drastically improved CPR performance in novices, there was a slight improvement again after a five minute video. The authors concluded that the ultra-brief one-minute video was short enough “to be used in a myriad of media venues” (p. 225) and as such was most likely to increase bystander CPR rates. This conclusion highlights the importance of context in the application of these design principles. While a student studying for a CPR exam or training as a first aider may benefit from watching the full video, a member of the public may be more likely to watch the entire 60 second video, making it a more effective public health video in terms of saving lives.

3.5.3.4 Segmenting

Segmenting involves breaking videos into short segments. It differs from video length reduction in that it requires designers to put pauses in a longer production, rather than (or in addition to) reducing the amount of content in the total video itself. Segmentation leads to higher learning gains, partly because it interrupts the continual stream of transient information which can lead to cognitive overload (Biard et al., 2018; Ibrahim et al., 2012; Mayer & Pilegard, 2014; Zaki, 2019). Segments or forced pauses in the video have also been shown to assist students in structuring information into schemas (Merkt et al., 2018). As with many of the principles in this chapter, the effect of segmentation has been shown to be most beneficial to learners with low prior knowledge, because it provides temporal cues to important information and provides pauses to allow students to perform essential cognition (Spanjers et al., 2012).

The previous section outlines both the theoretical and experimental evidence for the effectiveness of shorter videos running to five or six minutes, segments can be much shorter, particularly when dealing with complex material or novice learners. For example, Mayer and Chandler (2014) found that even segmenting a 140 second presentation into 16 segments of around 10 seconds each led to a large ($d = 1.13$) effect on learning. While it would be unwieldy to create 10 second videos as a matter of course, video interfaces that can automatically pause a presentation or divide it into chapters are available. While early research (Hasler et al., 2007) suggested that learner control, in which students have control over pause and play buttons goes some way to mitigating the need for segmentation, more recently Biard et al. (2018) showed that a combination of segmentation and learner control produces improved procedural performance. Furthermore, Cheon et al. (2014) found that including activities such as recall questions in the pauses between segments led to greater recall and transfer scores than passive pauses alone. This suggests that an optimal design for videos to be watched by novices may be to keep them short, and interpolate meaningful learning activities during pauses at strategic points.

3.5.4 Essential Processing Principles

The essential (CTML) or intrinsic (CLT) load of a learning task cannot be reduced as it describes the level of complexity intrinsic to the task for a particular learner. This is determined by the difficulty of the task, and both the prior knowledge and fluid intelligence of the learner. However, this learning process can be managed in such a way as to make best use of cognitive load. Mayer (2014b) describes this as "managing essential processing" (p. 63). This section outlines two design principles which manage essential processing, namely *learner control* and *pre-training*. These are summarised in Table 6. Again, for readers familiar with multimedia design principles, a notable exclusion from this list is *modality*, which is the understanding that narration outperforms written text. This review found a lack of evidence for the modality principle in literature using instructional videos as the learning medium and as such it has been excluded.

Table 6:

Essential Processing Principles for Instructional Video Design

Principle	**Design Implications**
Learner Control	Video interface should be designed so that pause, play, speed up and slow down buttons are usable and clearly visible to the learner.
Pre-training	Key elements required to understand a concept should be taught to novice learners prior to watching the video, either by a tutor or in a preliminary video.

3.5.4.1 Learner control effect

When compared to system paced presentations, learning gains from instructional videos have been shown to improve when learners are given control over the playback of videos (Hasler et al., 2007; Höffler & Schwartz, 2011; Kühl et al., 2014; Mayer & Chandler, 2001; Tabbers &

de Koeijer, 2010) so long as the interface is intuitive and does not increase cognitive load (Schwan & Riempp, 2004). In other words, in experimental conditions, if a learner has control over the pause, play and scrubbing (slide bar used to move forwards and backwards through a video) functions of the device playing a presentation, retention and understanding are often improved because it allows them to manage the transience of streaming information. Schwann and Riempp (2004) helpfully compared uncontrolled video information to a game of Tetris in which the player must "rapidly organise information at a rate they cannot change" (p. 295). Of course, learner-paced instruction has been found to take longer due to pauses and replaying, so it has been argued that "the benefits of introducing learner control in multimedia learning are at the expense of learning efficiency" (Tabbers & de Koeijer, 2010, p. 441).

Interestingly, the advantage of learner control can hold even when the students opt not to use the controls (Biard et al., 2018; Hasler et al., 2007). Hasler et al. (2007) found the very fact that the students knew they could pause the video led them to monitor the content more closely and the authors concluded that this prompted the comparison of new elements with existing schemas. In other words, the internal questioning of when to pause, caused students to analyse, rather than passively watch, the content. The learner control group engaged in active processing, while Hasler et al. (2007) suggested that the system-paced group "may have treated the animation as little more than a movie and given it very little thought" (p. 725).

In contrast to Hasler et al. (2007), who used primary school students as participants, Tabbers and de Koeijer (2010) recruited university students. These students used the interactive features such as pause and rewind extensively, averaging almost double the watch time spent in the control condition, and experienced a significant learning gain by doing so. A similar pattern of extensive use was found in senior secondary students studying History in research by Merkt et al. (2011). The secondary students mostly used the pause feature, indicating their "need to control the pace of the information flow" (p. 695), offsetting the transience of video information.

It should be noted that recent research (Koć-Januchta et al., 2020) has found system pacing leading to superior outcomes in college students learning from an animation when the system paced group watched the animation twice while learner control students were able to manipulate the animation for the same period. The same study also suggested that student cognitive processing style may have an impact on the impact of system vs learner pacing. This research suggests that the issue of learner pacing may be more complex than suggested in this section.

A notable problem in completing this literature review with regard to other principles was the fact that some methodologies encouraged learner control (Hasler et al., 2007), some allowed it (Guo et al., 2014; Ibrahim et al., 2014; Kim et al., 2014), and others prevented it (Ibrahim, 2012; Van der Zee et al., 2017). Such results are often not comparable. For instance, Ibrahim et al. (2012) claimed to establish the effectiveness of segmentation, but prevented learner control of videos. Similarly, Leahy and Sweller (2016) examined the transient information effect by first segmenting a presentation, then further segmenting it until they achieved a modality effect. At no point did the researchers give learners scrubbing capabilities, which may offset the transient information effect due to the ability to pause, rewind and easily find appropriate elements. This lack of learner control has been identified as a threat to the ecological validity of lab based research (Park, Knörzer, et al., 2015).

3.5.4.2 Pre-training principle

The pre-training principle posits that learners experience greater learning gains if they are provided “pre-training concerning the names and characteristics of the major elements in the lesson” (Mayer & Pilegard, 2014, p. 194). This pre-training can take the form of another instructional multimedia resource which introduces the pertinent elements as was demonstrated by Kester et al. (2006), or could simply be an introduction to key terms by the classroom teacher. The pre-training principle relies on one of the fundamental theoretical precepts of cognitive load theory, namely that while long term memory is extensive, working memory is very limited. Cognitive overload arises when the number and interactivity of elements that a learner is required to process is larger than their cognitive load capabilities. Pre-training, on the other hand, reduces the number of novel elements to be learned during the following instruction.

3.5.5 Generative Processing Principles

Generative processing principles encourage active, rather than passive, engagement with the media. CTML posits that to construct accurate working mental models, which is the goal of learning, learners need to actively select and process novel material and integrate this material with pre-existing schemas. There are three principles in this section, and they are summarised in Table 7 before being more fully explained in the following sections.

Table 7:

Generative Processing Principles for Instructional Video Design

Principle	Design Implications
Integrated activities	Designers should integrate practice questions or activities, either during pauses in the presentation or following the video.
Personalisation	Narration should use conversational, first person voice, with enthusiasm.
Misconception Effect	Conceptual videos should begin by dispelling common misconceptions.

3.5.5.1 Integrated Practice Activities

The incorporation of interactive questions or activities in videos, as pop-ups and quizzes during, or to a lesser degree reviews or tasks following the video, has been shown to have beneficial effects on student learning (Cheon et al., 2014; Delen et al., 2014; Koedinger et al., 2015; Szpunar et al., 2014; van der Meij, 2017; Vural, 2013; Zaki, 2019). Szpunar et al. (2014) also found that incorporated learning activities can help to correct adolescent student overconfidence (calibration between expected and actual performance) when learning from videos by allowing students to self-check their understanding. Most importantly, the Szpunar et al. (2014) found that by interpolating practice tests throughout playback, student performance on a summative test was improved with a very large effect size of d = 1.63. Koedinger et al. (2015) found a similar outcome in a Psychology MOOC, in which adult students who engaged in activities beyond passive video watching were predictably more likely to achieve high grades, and less likely to drop out.

In a more practical application, Bobrow et al. (2011) found that adults who watched a five minute video explaining correct CPR technique followed by three minutes of video-guided practice on a mannequin were significantly more likely to perform the correct compression technique than those who watched only the video. This effect persisted even after a two-month delay. Incorporating activities such as quizzes in videos has also been found to extend the time a student was likely to pay attention, potentially serving to increase the optimal video length (Geri et al., 2017).

Clark and Mayer (2016) described three principles to guide the design of practice activities:

1. add sufficient practice interactions to achieve the learning goal,
2. include questions that mirror the application of the knowledge (ie, transfer questions),
3. provide effective feedback.

These three principles are centred on the key role of instruction in CTML, namely facilitating the construction of effective mental models. As such, questions optimally go beyond simple recall of information, as these are not likely to encourage a working mental model translating to expert performance. However, in findings that complicate integrating practice activities, Yeh et al. (2010) found that the optimal type of activity differs for high and low prior knowledge learners. In an instructional treatment on a complex binary coding technique, they found that for higher knowledge students, an open-ended predictive activity in which student predicted the next part of the animation then corrected their predictions produced better transfer performance. For lower knowledge students, learning was optimised when the activities were guided *fill the blank* style statements based on the animation they had just seen. For teachers in a mainstream context, these findings suggest that worksheets, quizzes or other activities should be tailored, as much as practical, to the learning capabilities of each student.

3.5.5.2 Personalisation Principle

The personalisation principle suggests that videos produced with a human voice, conversational and enthusiastic style, and first/second person speech activate a social response in the learner and in turn an increase in active cognitive processing (Clark & Mayer, 2016). This produces superior learning outcomes when compared to a formal, academic or depersonalised approach (Mayer et al., 2004; Rey & Steib, 2013).

A body of experimental work (Mayer et al., 2004; McLaren et al., 2011; Moreno & Mayer, 2000; Rey & Steib, 2013) has established that replacing formal third person style speech with a conversational tone including “you” and “I” statements leads to an improvement in learning. Notably, Mayer et al. (2004) found that simply by substituting the word “the” for the word “you” on 12 occasions in a 60 second narrated animation on respiration led to greater performance by first year college students on transfer tests, with no effect on retention tests, suggesting a generative effect. In addition, van der Meij (2017) demonstrated positive learning outcomes when adopting ‘you’ statements in initial instruction and ‘I’ statements in a final review at the end of the video, in order to mimic internal mental rehearsal. More recently, a similar increase in affective measures and transfer performance among undergraduates studying business was discovered simply by increasing the enthusiasm of the presenter’s voice (Liew et al., 2020). These results support the ICALM proposition of attributed affect, meaning the ability of media to impact the emotional state of learners and indicate a rather intuitive conclusion, that students learn from enthusiastic and personable instruction.

3.5.5.3 Misconception Effect

Video designs dealing with conceptual change that incorporate the refutation of misconceptions lead to superior learning outcomes when compared to those that are simply comprised of instructional exposition (Muller, Bewes, et al., 2008). In other words, to help students rectify incorrect presumptions about an idea, videos are most effective when they first dispel those misconceptions before presenting the accurate information. This can be achieved via a direct refutation of commonly held misconceptions at the beginning of a video, or through a recorded Socratic dialogue between teacher and student (Muller, Sharma, et al., 2008). This suggestion is supported by the work of Gadgil et al. (2012) who found that students who are asked to explain the difference between their own flawed scientific understanding and an expert model learned better than those who simply explain the expert model.

The inclusion of such misconceptions is theorised to encourage germane processing because they provide explicit references to existing schemas (albeit incomplete or incorrect ones) and as such prompt learners to refine existing mental models (Muller, Bewes, et al., 2008). Given that only two studies were found to have isolated this effect, there is a need for both its theoretical and empirical development.

3.6 Summary

This Chapter explored the literature dealing with the effective design and use of instructional videos. The first half of the Chapter revealed that instructional videos can be useful in a range of pedagogical applications, but that there is a lack of research about the way they are utilised in mainstream secondary classrooms. This study sets out to identify what these practices are. Secondly, in order to accurately describe the types of instructional videos teachers selected, a classification table was developed from the existing literature.

In the second half of this Chapter, the literature on the effective design of videos revealed that much of this work has been carried out using experimental designs and analysed through the lens of CLT/CTML. A systematic review of 110 studies revealed nine design principles that have been shown to have a positive effect on learning. While these evidence-based principles present one way teachers could make choices about the selection and use of instructional videos, these principles could also be complicated when applied to real learning contexts beyond the experimental lab.

In Chapter 6 and 7, the analysis of the case study data in this study uses the terminology introduced in this chapter to make sense of teacher considerations. The study also explains the extent to which these principles are consistent with the ways in which educators in real classroom contexts select and use videos. Importantly, it also explores the deviations teachers make from these principles based on other knowledge. The next chapter explains the methodology for this study, which is designed to reveal the knowledge teachers use when selecting and using instructional videos, and the contextual realities in which teachers enact that knowledge, the particulars of which may talk back (Flyvbjerg, 2006) to the experimental literature.

Chapter 4: Case Study Methodology

The previous chapter outlined the vast and growing corpus of literature outlining ‘effective’ design and use of instructional video. A limitation of this research base is that only a tiny fraction has been developed in mainstream secondary school contexts and the perspectives of teachers working in real classrooms are largely silent. The best practices advocated in the literature rarely account for the range of factors teachers have been shown to consider when making pedagogical decisions (Loughran et al., 2016). This chapter outlines the methodology, a multiple case study (Merriam, 1998; Yin, 2009) which uses Shulman’s (1986) framework, outlined in Chapter 2, as a way of interrogating the ways teachers select and use instructional videos, and the role of knowledge and context in this process.

4.1 Paradigm – the state-of-the-actual

Struck by the way in which research on educational technology tended to focus on what should or could happen, Selwyn (2008) called for researchers to instead critically examine what is actually happening. Selwyn (2014) later explained that:

> …the overriding change that this entails is shifting the field away from asking ‘state-of-the-art’ questions about technology, and towards asking questions that can be described as being concerned with the “state-of-the-actual.” In other words, educational technology scholarship should look beyond questions of how technology could and should be used, and instead ask questions about how technology is actually being used in practice. (p. 15)

In particular, Selwyn (2008) criticises “a pronounced tendency to focus only on the positive aspects of education technology use” stemming from “in-depth case studies of ‘model’ schools and classrooms, enthusiastic teachers and well-resourced students basking in the glow of the

‘Hawthorne effect’ of research attention” (p. 83). More recently similar calls for consideration contextual issues have been made in relation to applying the results of random control trials to educational reform (Joyce & Cartwright, 2020). A deliberate focus on realism, on recording and analysing the actual experiences of teachers in context could be seen as the paradigm or worldview of this study.

Importantly, the term *state-of-the-actual* (Selwyn, 2008, p. 83) does not suggest the existence of a solitary fixed reality as implied by the singular ‘*the*’ but instead describes an analytical approach that chooses to take notice of the sociological, political, and personal contexts in which educational technologies are used. Necessarily this means that when using the state-of-the-actual as an analytic lens, multiple dynamic and personal actualities will be identified. Perhaps an easy way to conceptualise this distinction is to imagine an investigation of the use of technology in a particular school through this lens. Such an investigation would sideline state-of-the-art claims in a school’s prospectus. It would, instead, examine the messy realities of technology in school life that this author has experienced firsthand: the drained batteries, the successful integrations, the frustrated teachers, the technology sales-pitches, the levels of engagement amongst students, the interruptions to internet connection. So, when I use the term state-of-the-actual, I describe an approach problematising claims of state-of-the-art or best practices, rather than one singular or fixed reality.

As is demonstrated by the literature review in Chapter 3, prior research in the effective design and use of instructional videos has adopted a range of epistemological and methodological frameworks. Common to the vast majority of this literature, however, is a tendency towards discovery of universal best practices by which teaching and learning can be improved. While valuable, such approaches, that either eliminate classroom realities (in the case of experimental designs) or focus on atypical interventions (in many case studies) do little to add to our understanding of ordinary teacher experiences and the labour of teaching. A focus on the state-of-the-actual also problematises knowledge frameworks that suggest what teachers *should* know, instead seeking to interrogate what they *do* know. What teachers actually know and how they use that knowledge will of course be different for each individual.

Such a worldview requires a rigorous methodology in order to establish credibility and therefore provide valuable contextual criticism to theory. The following sections explain how theory and methodology have been drawn on to construct a study that deliberately problematises best practices in the selection and use of instructional videos. This aims to not only contribute to the literature base by exploring the describing the state-of-the-actual for teachers, but to use this data to critically analyse the existing best practice literature. At times, this results in confirmation or strengthening of the existing literature, but the consideration of teacher knowledge and context also leads to alternative explanations previously underexamined in the literature.

4.2 A Research Framework

The present study seeks to understand and explain teacher selection and use of instructional videos, with a particular focus on the impact of teacher knowledge and context on this process. As such, this research is grounded in Shulman's (1986) framework in order to make sense of teacher knowledge, while drawing on CLT/CTML (Section 3.3) and the ICALM (Section 3.4.2) as theoretical lenses through which teacher ideas about video design and student interaction with videos can be understood.

Shulman's writing on teacher knowledge, and indeed that of Mishra and Koehler (2006) in the development of TPACK, is rooted in a constructivist paradigm. Influenced as it is by the identity of the individual teacher, and mediated through the specific context in which teachers practice, the knowledge teachers draw on when making decisions is ultimately "personal and private knowledge, rather than a public or objective knowledge" (Hashweh, 2013, p. 121). In contrast, despite a focus on students constructing working mental models (Mayer, 2014b), the experimental designs preferenced in CTML/CLT (Mayer, 2014a) tend to present a positivist view of knowledge as context independent. Because of this, these two theoretical lenses initially seem to stand in conflict, and holding them in tension was a source of much reflection throughout the writing on this study.

Drawing from the tradition of pragmatism (Russo, 2017; Teddlie, 2009) which argues that research should use the most appropriate tools in order to answer the question at hand, these two frameworks are drawn upon to investigate the phenomenon of teachers' selection and use of instructional videos to a depth that either alone may not have afforded. In short, a study based only on identifying whether teachers followed principles identified in CTML/CLT would fail to consider the other types of knowledge teachers draw on. Equally, Shulman (1987) suggested that teachers should be aware of pedagogical scholarship, including how cognition relates to teaching, but did not expand on the specifics of this knowledge. So, while Shulman's framework provides a powerful way of parsing teacher knowledge sources, CLT/CTML and the ICALM provides a framework and language by which to make sense of the explicit and tacit knowledge teachers had about video design more specifically. For example, a teacher may express that they choose simple videos so as not to overwhelm their students. While this draws on what Shulman calls knowledge of learners and their characteristics (to identify what might overwhelm particular students), it also implies a tacit knowledge of the limited capacity principle in CLT/CTML.

4.3 Methodological Approach – Multiple Case Study

In choosing a multiple case study approach for this research, I was guided not by a predisposition towards qualitative research but by the principle that “methods are only more or less appropriate to particular research questions” (Silverman, 2017, p. 10). This research seeks to explain the state-of-the-actual (Selwyn, 2008) concerning how teachers in mainstream secondary schools select and use instructional videos and as such a methodology was required that interrogated the subtleties and complications involved in this process, including the role of teacher knowledge and the contexts in which teachers work.

Experimental methods have been used extensively to investigate the cognitive architecture of students and impact of video design on learning in very controlled environments (see Chapter 3). But cognition is not the only factor that teachers must consider when selecting learning materials such as instructional videos. The myriad complications of school life influence the pedagogical decisions made by teachers, including classroom interruptions, student pastoral needs, teacher motivation, device availability, teacher expertise, availability of content, curriculum demands, and school systemic demands (Philipp & Kunter, 2013; Ruppar et al., 2015). These complications cannot, and perhaps should not, be controlled for in experimental designs, but they may be important factors in teacher decision making and case studies provide the opportunity to examine these factors. Case study research also allows subjects and contexts to talk back and reveal subtleties and blockers that prevent the application of principles found to be effective in experiments (Flyvbjerg, 2006).

Equally, however, a multiple case study affords an opportunity to evaluate whether Shulman's (1986, 1987) framework of teacher knowledge remains applicable to a digital world, and whether TPACK is an appropriate way of conceptualising knowledge about the technologies involved in selecting and using instructional videos. Shulman (1987) claims that his seminal essay *Knowledge and Teaching: Foundations of the New Reform* addressed what he saw as an unanswered question concerning "what teachers *should* know" (p. 4, emphasis added), rather than describing what most teachers *actually* know. He went on to explain that "In this paper, I present an argument regarding the content, character, and sources for a knowledge base for teaching that suggests an answer to the question of the intellectual, practical, and normative basis for the professionalization of teaching" (p. 4). TPACK has also been described as an "aspirational mixture" (Phillips, 2014, p. 116) of knowledge types.

Case study methods are inherently threatening to conceptions of theoretical best practice precisely because they attempt "to make routine features of everyday life problematic by describing what actually happens in some setting" (Silverman, 2017, p. 18). As such, while both frameworks may well describe an ideal knowledge base for teaching, this study is deliberately focused on whether these frameworks do, or are even able to, describe the actual state of teacher knowledge when selecting and using instructional videos.

4.3.1 Designing the study

This research design draws most directly from the approaches to case studies advocated by Yin (2009) and Merriam (1998). The two methodologists offer views of case study research that intersect and complement each other in terms of methods, while at times contrasting epistemologically. These two approaches were chosen in preference to other methodologists such as Stake (1995) or Lincoln and Guba (1986) whose approaches, whilst powerful in richly describing single cases, are sceptical of suggesting trends across multiple cases, which is an aspiration of this study.

Both Yin and Merriam agree that case studies seek to establish "meaning and understanding, and that the researcher is the primary instrument of data collection" (Merriam, 1998, p. 266). In data collection, Yazan (2015) highlights that both Yin and Merriam agree multiple sources should be drawn upon to improve the quality of conclusions and "to capture the case under study in its complexity and entirety" (p. 142). Yin (2009) provides clear guidance on the types of evidence a researcher should use to triangulate findings, enumerating six categories of data, including quantitative data. Merriam (1998) instead focuses on the actual process of collecting data, such as conducting effective interviews, being a careful observer and mining documents. The present study adopts a gestalt of Yin and Merriam's approaches, following Patton (2002) who argues that "the practical mandate in evaluation to gather the most relevant possible information… outweighs concerns about methodological purity based on epistemological and philosophical arguments" (p. 273). The rest of this chapter outlines the resulting methodology adopted for this research.

Importantly, all of the protocols, methods, and data storage processes described in this chapter were approved by three relevant ethics bodies, namely: Monash University Human Research Ethics Committee (MUHREC; project 11676), Diocese of Sale Catholic Education Limited (DOSCEL), and the Catholic Education Office Melbourne (CEOM; project 0755). These ethics approvals are included as Appendix D.

4.3.2 Determining a case

Researchers have offered varying definitions of how cases themselves are defined. Defining a unit of analysis is synonymous with determining what equates to a single case in the study (Yin, 2009). While superficially this is a simple task, the reality is that this project involved various units that coexist in dynamic interplay, calling into question the definition of a case as an isolated entity "around which there are boundaries" that can be "fenced in" (Merriam, 1998, p. 40). Unlike Merriam, Cargan (2007) sees cases as intrinsically intertwined with the wider contexts in which they are located. Phillips (2014) further problematises the idea of a neatly bounded case, pointing out that "a question such as 'where does phenomenon end and context begin?' quickly unravels the idea that cases and contexts can be neatly bounded and traced" (p. 121).

The decision as to how to consider the case was made when it was revealed in the data that teachers rarely worked together, and that school-wide policies on video use were not influential. In short, teachers usually selected and used videos alone. Therefore, each teacher was considered a single case, making a total of nine cases. Each teacher's knowledge base was analysed independently, along with the contexts in which they worked. Differences and similarities were closely examined, representing "a strong start toward theoretical replication" (Yin, 2009, p. 61).

In a few instances school culture had an impact on teacher reasoning and action. For example, Helen chose not to show a particular video to her Science class because she thought it might transgress what she perceived as Station College's conservative culture. These instances, however, were less impactful than teacher knowledge and therefore the schools were not treated as another unit of analysis. The reality that both sites were Catholic schools in the Eastern suburbs of Melbourne may also have contributed to the lack of divergence between contexts. A study in a variety of schools from different sectors in difference locations may have identified greater divergence.

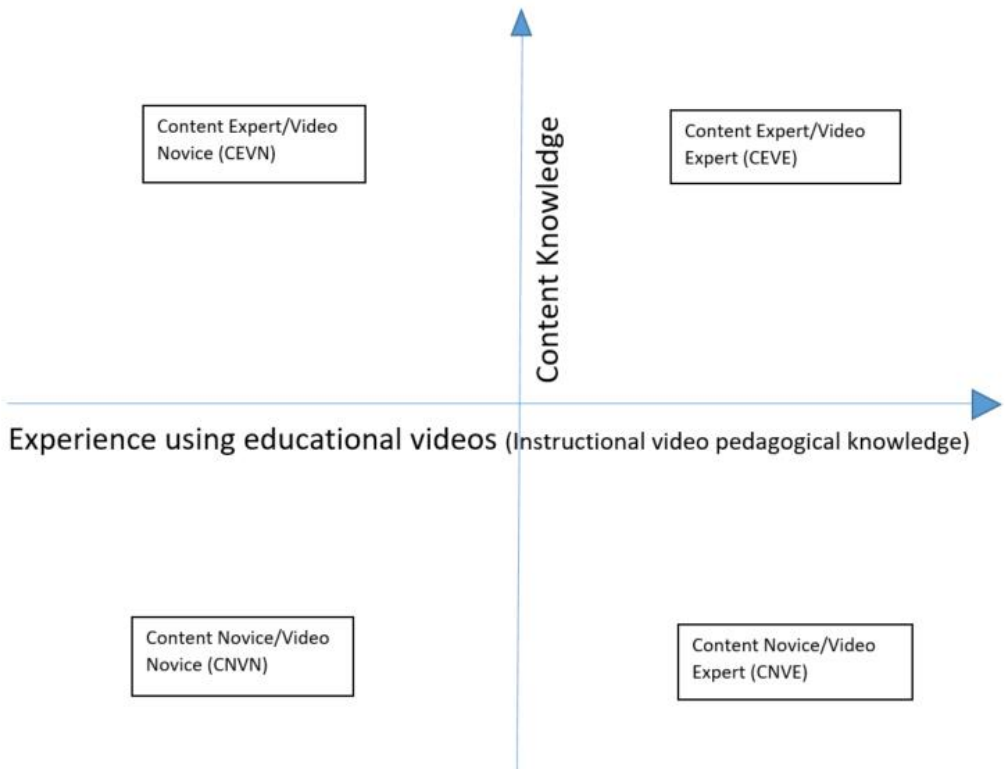
4.3.3 Selection of Participants

Unlike quantitative research, which emphasises randomness and therefore generalisability, case study research emphasises “information rich cases for study in depth” (Patton, 2002, p. 273). Merriam (1998) argues for “purposeful sampling” (p. 77), by which a range of cases are deliberately selected that together present telling data. The particular method of selection chosen for this multiple case study is a form of “maximum variation” among teachers (Merriam, 1998, p. 78). By this, Merriam advocates that cases are selected precisely because they differ from each other in potentially meaningful ways. In the context of this study, these variances include career stage, subject domain, and technological knowledge. Yin (2009) was wary of the term sampling, traditionally aligned as it is with experimental designs, but broadly agreed with the approach styling it “theoretical replication” (p. 54). Yin suggests that if the variance between cases produces results consistent with theoretical or conceptual predictions, then the theory or conceptual framework is replicated, thus providing support for the claim.

In order to achieve some theoretical variation in participants, and to satisfy the demand of representing the state-of-the-actual, rather than a homogenised view based on exemplar teachers, the Principals of the two schools chosen for this study (see Sections 5.1/5.2) were asked to nominate between four and six teacher participants who differed in content expertise and experience using technology, particularly videos. Each Principal chose to delegate that task, and the two representatives were the E-Learning Coordinator at Station College and the Vice-Principal of Teaching and Learning at Wayfarer College. Figure 3 depicts a quadrant with vertical axis labelled *content knowledge* and the horizontal *experience using educational videos (instructional video pedagogical knowledge)* and this was presented to the representatives as a way of explaining the variance of participants required for the study.

Figure 3:

Quadrant to guide selection of participants



The figure describes the content knowledge of a teacher and their experience or expertise in using instructional videos as part of their pedagogical practice in an accessible way. As part of the ethical approval for this study, the Principal or representative needed to approach potential participants, and these two factors were identified as both easily identifiable and potentially powerful drivers of divergence in practice. The quadrant was not derived from the theoretical principles evident in the literature, and serious concerns could be raised regarding plotting knowledge on a graph as if it were linear, not to mention the lack of the other types of knowledge in Shulman's framework. However, the figure was useful in efficiently communicating a difficult concept to time-poor educational leaders and was effective in practice. Both representatives expressed confidence that they would be able to find teachers in each quadrant and this was borne out in the range of participants chosen (see Chapter 5). While the quadrant plays no further part in this thesis, it ensured that the participants in this study represented, if not *maximum* variation as Merriam suggests, at least provided a framework by which a level of variation was achieved that avoid the kind of skewed data that may have occurred had each school selected only their most technologically savvy teachers.

4.4 Methods of Data Generation

Yin (2009) argues that, in case study research, an "essential tactic is to use multiple sources of evidence, with data needing to converge in a triangulating fashion" (p. 2). This section outlines the methods adopted in this study order to generate data for analysis. The term *data generation* is used in tandem with the more common *data collection* because, as Phillips (2014) identifies, in case study research, "amassing a data set is not a neutral process but actively involves authoring particular accounts" (p. 124), particularly when conducting interviews and writing observation notes. The researcher is therefore intimately involved in the creation of data in contrast to the deliberate distance established in experimental methods.

Data was generated at five points for each participant (see Figure 4). Over the course of the second semester of the 2018 Victorian academic year, each participant was interviewed twice, and the researcher observed their classroom practice once. Following initial data analysis, each participant was presented with an initial summary of their knowledge use and a tailored review in the form of a questionnaire asking for further reflections on their previous answers. Each participant took the opportunity to respond in writing and the dates for that review is recorded in the table. In addition, the researcher was in regular correspondence with the participants via e-mail when clarification was needed, or when the participants wished to inform the researcher about the use of a particular video in their class. The number of e-mails exchanged, not counting those of a purely administrative nature (such as organising interview times), are recorded in Table 8 as an indication of the extent of this communication.

Finally, in response to a surprising lack of ClickView (a subscriber based educational video platform paid for by each school) videos in the data, sitewide usage statistics of that platform were gathered from the IT departments at each college (see Section 7.3.2). These were confirmatory in nature and therefore did not alter the final analysis.

Figure 4:

Sequence of data collection and analysis

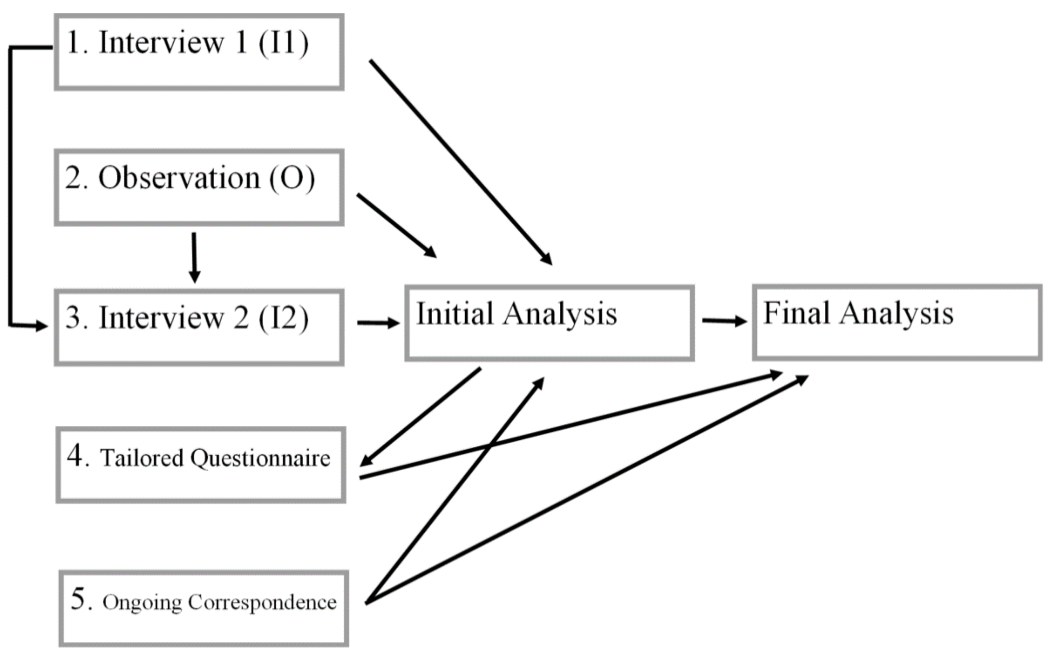


Table 8:

Data Collection Details

	Interview 1	Observation	Interview 2	Review	e-mails
Station College					
Helen	24/07/2018	31/08/2018	6/09/2018	11/09/2019	8
Margaret	27/07/2018	15/08/2018	15/08/2018	15/09/2019	11
Dennis	27/07/2018	28/08/2018	28/08/2018	8/09/2019	4
Carl	20/08/2018	4/09/2018	4/09/2018	7/09/2019	7
Wayfarer College					
Lucy	17/09/2018	20/11/2018	20/11/2018	6/10/2019	8
Troy	18/09/2018	10/10/2018	2/11/2018	5/10/2019	5
Alison	11/10/2018	7/11/2018	7/11/2018	7/09/2019	8
Melissa	10/10/2018	31/10/2018	31/10/2018	4/10/2019	11
Louise	10/10/2018	17/10/2018	17/10/2018	17/09/2019	6

These five data collection points and variety of evidentiary sources are used to triangulate the data for greater reliability and data validation (Yin, 2009). Divergent data sources were of particular interest as they indicated areas requiring careful investigation (Farquhar & Michels, 2016; Flyvbjerg, 2006). It should be noted that some (Richardson, 2000) have criticised the use of the term *triangulation*, preferring instead to speak of *crystallisation* – with the crystal refracting in many dimensions while the triangle is a two dimensional plane. Working within the field of creative ethnography, Richardson (2000) is sceptical that a fixed point of truth can ever be triangulated, because each account is authored, and therefore subjective. Throughout this thesis, while the more common term triangulation is used to describe data sources converging to build trustworthiness concerning the processes and knowledge teachers use, I recognise that the account and analysis is but one perspective. The following sections explain the reasoning behind the methods of data generation in more detail and explain how each is used to author this particular account.

4.4.1 Interviews

Interviews are "one of the most important sources of case study information" (Yin, 2009, p. 106). This study aims to describe the complicated factors influencing the knowledge and pedagogical reasoning of teachers in Australian secondary schools and while some of these factors might be predicted, the interaction between them and their relative importance is more thoroughly explored through the use of semi-structured interviews. These strike a balance between the rigid, closed-ended approach of a survey which is useful when all categories for analysis are already known, and a thoroughly unstructured conversational style favoured by some ethnographers which are "really more conversations than interviews" (Leech, 2002, p. 665). Semi-structured interviews have a clear theoretically driven structure, but allow the researcher to divert from the prescribed questions when participants question the underlying assumptions, or reveal novel avenues of inquiry (Flyvbjerg, 2006; Merriam, 1998). The decision to conduct two interviews separated by a classroom observation further allowed the researcher to divert from the prescribed questions in order to clarify answers or probe reasoning for particular classroom decisions. This would be more difficult with a single interview design.

The semi-structured interview design was guided by Shulman's (1986, 1987) framework of teacher knowledge. This provided both a natural structure to the interviews, while also providing a framework for theory development in data analysis. As Leech (2002) suggests, when planning interviews, "what you want to know determines which questions you will ask, [while] what you already know will determine how you ask them" (p. 665). The actual guiding questions were developed using Merriam's (1998) framework for effective questioning in case study interviews. They were designed to elicit the knowledge of each teacher as broadly explained by Shulman (1986; see Chapter 2), their selection and use of instructional videos, and the ways in which contexts played into this process. The interview schedule with identified themes and prompts as is usual for semi-structured interviews (Merriam, 1998) is included as Appendix E.

4.4.2 Classroom Observations

Unlike interviews that record the constructed recollections of teacher practice, mediated through memory and identity, observations afford the opportunity to encounter firsthand teacher instructional practice, the practical output of teacher knowledge and reasoning (Merriam, 1998). A further advantage of observations is that they can confound the common dyadic research model, in which only researcher and subject are considered, to take into account the subject's complex social and environmental setting (Bronfenbrenner, 1976). Because, in this data generation method the researcher, rather than the participant, is the primary author of the account, I was particularly aware of my own presuppositions and perspectives, and subjected my assumptions about the observations to vigorous member checking during the second interview.

A limitation of classroom observations is that this kind of data generation can suffer from what has been called the *Hawthorne effect*, in which the obvious presence of a researcher inherently and often subconsciously changes participant behaviour (Hagel et al., 2015; McCambridge et al., 2014). Despite the best efforts of the researcher to avoid influencing teacher behaviour and to reassure participants that they were not being rated, the reality is that "at the very least, participants who know they are observed will tend to behave in socially acceptable ways… and to regulate their behaviour based on subtle feedback" (Merriam, 1998, p. 127). Care was taken to talk through the degree to which each observation class was typical of the teacher's practice in order to build the credibility of the data. This member checking was combined with checks "for communicative validity and trustworthiness, including triangulation" (Phillips, 2014, p. 131).

Each participant was observed teaching one class in which an instructional video was planned to be used (even though Alison and Melissa subsequently chose not to show a video, and Margaret showed a narrative film). To avoid a feeling of "ambush", the researcher gave control over which class to observe to the participant, waiting to be invited rather than presuming permission. Merriam (1998) provides six broad elements to observe in a setting and these were used to guide my field notes during observations. These are (1) the physical setting; (2) the participants; (3) activities and interactions; (4) conversations; (5) subtle factors; and (6) researcher behaviour. Appendix F is a copy of this observation guide, and a list of codes used to record observations.

Importantly, during the observation process, the focus of attention was teacher behaviour, not students. No audio or video recordings were made to avoid any invasion of student privacy. When observing a teacher's interactions with students, notes were made in such a way as to eliminate any chance of identifying individual students. This was in line with the suggestions made by Monash University Human Research Ethics Committee and endorsed by both the Catholic Education Office Melbourne and the Diocese of Sale Catholic Education Office.

4.4.3 Correspondence

Participating teachers were invited to e-mail the researcher any additional instructional videos they used throughout the data-collection period in any class. For each video, they were asked to give a one or two sentence description of what the video was used for and why they chose it. This struck a balance between placing excessive demands on teacher time and helping to build a more representative picture of the types of videos used. In addition to those gathered during interviews (which were recollections of videos used prior to the data collection period), this resulted in a collection of 58 videos used by the nine participants (see Appendix G). When videos were mentioned (in interview or correspondence), participants were also asked how they found it, how it was shown to students, and how effective they thought it was. The researcher also shared e-mail conversations with participants when interview transcriptions posed unanswered questions. These conversations constituted another form of data. Data from these reflections and other communications outside of the interviews and observations are referenced as ‘personal communication’ in this thesis.

4.4.4 Member Checking

Case study research emphasises the voice and subjectivity of participants, deliberately avoiding “the deadening thud of an aggregate statistic” (Silverman, 2017, p. 8). Member checking, or asking participants to check that analysis fairly represents their perspectives, is a way of ensuring not only that participants voices have been recorded, but that these descriptions are authentic. Following initial data analysis (as described in the next section), each participant was presented with a chance to review reflections on their use of knowledge based on the analysis and complete a follow-up tailored questionnaire (see Figure 4, Section 4.4). Each teacher was asked for their input on these reflections as a form of member checking, following the suggestions of Carlson (2010). Carlson suggests that participants should be given a choice of how to provide feedback on analysis, and as such each teacher was given the option of e-mail correspondence or a follow up interview. All participants chose to correspond via e-mail at this point and as such these responses are also referred to as personal communication. The timing of this member checking (see Table 8) allowed enough time to pass for teachers to reflect on their practice following the initial interviews, and for the researcher to re-code and re-analyse the data after this additional input. As such, the concern of Birt et al. (2016) that “member checking is often left to the closing stages of a project when there might be insufficient resources to give little more than a cursory nod to further validation techniques” (p. 1807) was addressed.

4.4.5 Limitations of Data

Despite the rigorous approach to data triangulation and member checking, there are inevitable limitations of case study data. In addition to the Hawthorne effect (see Section 4.4.1), the social desirability bias suggests that during interviews, subjects are more likely to offer responses in line with their predictions as to what the researcher wants to hear (Desimone & Le Floch, 2004; Merriam, 1998; Yin, 2009). Particular care was taken to assure the participants of their anonymity, and that I was seeking the actual reality of teacher experience rather than an ideal. Perhaps as a result of this, participants did at times offer answers that may have been professionally embarrassing if identified. This builds the trustworthiness of the data set.

A limitation that emerged as interview data was triangulated with other data sources was that teachers at times did not accurately recollect the sources of the videos they used. For example, several of the teachers initially explained that they used a variety of video sources, such as ClickView, ABC *Splash*, DVDs, *EdRolo*, and even *Netflix*. However, when asked to provide links to specific videos they had used, the majority were sourced from YouTube. This was even true of participants who professed a sceptical attitude towards the YouTube platform. Another example of teachers being seemingly unaware of their own search strategies was one participant who claimed she would visit a colleague's YouTube channel before looking elsewhere. When asked to find the channel, she had to play a video to check if it was her colleague's voice, then was surprised to find the colleague only had a handful of videos, all of which were several years old. Finally, two teachers who taught the same subject both claimed that they shared all resources and that the teaching team often used the same videos, but were unaware that they had each searched for, found, and used different videos on the same topic. It was this revealed limitation of the interview data that showed the value of data triangulation and therefore a strength of the research design.

Finally, this data was collected from only nine teachers at two schools. Claims about practices, such as the dominance of YouTube, may not be true in schools that make use of other services in a more systematic way. Certainly, junior Mathematics classes at Wayfarer had adopted a platform called *Maths Pathway*, and this reduced the use of YouTube as a search tool in Louise's class. Both schools gave fairly open access to YouTube for students and staff. It may be that differing levels of access may affect usage. Finally, both schools studied had excellent internet access, and impaired access to online resources has been shown to be a blocker to teacher use of technology (Tarus et al., 2015).

4.5 Challenges particular to case studies

While this chapter has so far sought to establish a rigorous and appropriate research design, multiple case studies are not without challenges, particularly with regard to establishing reliability and generalisability. In advocating for a case study approach to recording teaching excellence, Shulman (1992) explained that teaching is “messy” (p. 7; see also Eisner, 2002). While case studies are particularly suited for exploring such phenomena that are intimately interwoven with context and difficult to quantify, this has historically led to criticisms concerning the reliability, generalisability, and validity of the resulting findings (Flyvbjerg, 2006; Lincoln & Guba, 1986; Phillips, 2014). In short, Henderson (2007, p. 83) asks “how do we know that the data, analysis and conclusions represent what actually took place, and, furthermore, that the findings are applicable outside of the particular context of the case study?” The following sections deal with these criticisms, drawing on Yin (2009) and Merriam (1998) to recast validity as *credibility*, reliability as *consistency*, and generalisability as *transferability*.

4.5.1 Credibility and consistency

From a positivist perspective, internal validity relates to how closely the findings match objective reality. While Yin (2009) accepts the concept of internal validity, he suggests it only really applies to explanatory case studies, not descriptive ones. Merriam (1998) recasts internal validity as credibility, the standard of which is met if perspectives of those involved in the phenomenon of interest have been accurately recorded. Credibility has alternatively been described as trustworthiness, or “the degree to which a reader has faith in the study’s worth” (Lankshear & Knobel, 2004, p. 366). It is this aim that shall be adopted, and as Merriam suggests, it is achieved through data triangulation and rigorous member checking, as described in this chapter.

Similarly, Merriam (1998) finds the traditional scientific standard of reliability, by which research is evaluated according to its replicability, a poor fit for qualitative research because the nature of human behaviour is “never static” (p. 220). Replicating a case study may well unearth different findings not because of flaws in design but because of the changing nature of the phenomenon in question.

For example, interviews are not an inert process completed under general anaesthetic, whereby information is extracted without affecting the patient. Patton (2002) explains that interviews are “a directed, reflective process that affects the persons being interviewed and leaves them knowing things about themselves that they did not know” (p. 278). This reflexivity entails an observer effect and “once interviewed” participants are never entirely typical of the population again, precisely because the interview process affords a potentially transformative experience. It is, therefore, unlikely that a subsequent interviewer would elicit identical data by replicating the interview. Because of this reality, Merriam (1998) accepts Lincoln and Guba’s (1986) reconceptualisation of validity as consistency - that given the same data, another researcher would agree that the findings make sense.

Following Phillips (2014), the credibility and consistency of this study is improved by adopting strategies such as:

- including longer sections of interview data to allow readers to evaluate the interpretations and develop rival explanations (Merriam, 1998);

- including “deviant cases” (Silverman, 2017, p. 392), or data that does not support my analysis;
- providing detailed descriptions of research and analytic decisions, including areas of doubt;
- providing access to the actual videos teachers selected by including web addresses in Appendix G, thus allowing readers to make judgements about any categorisation or commentary on the media.

4.5.2 Transferability and analytic generalisation

Merriam (1998) points out that while it is difficult to use a single case to argue meaningfully about the wider population, the reverse is equally true, in that making assumptions about individuals based on broad trends is unreliable. Instead, she argues, case study research seeks transferability, meaning the ability for a reader to apply the findings to a new situation that they know well. The example is given of a school principal who may seek case study research set in similar schools to her own when planning policy. It is up to the researcher to provide a “rich, thick description” (Merriam, 1998, p. 227) of the case so that the reader themselves can determine the level of transferability. Joyce and Cartwright (2020) downplay broad generalisability in educational research, arguing that local transferability is the ultimate aim because “after all, for educators, a successful intervention is one that contributes to a positive effect for them regardless of whether it can do so elsewhere” (p. 1059).

Yin (2009) agrees that comparisons between the kind of generalisability in case studies and in survey research are misleading but does not discount generalisability outright. Instead, while “survey research relies on *statistical* generalisation, case studies (as with experiments) rely on *analytic* generalisation” (Yin, 2009, p. 43, emphasis in original). Analytic generalisation refers to building theory, rather than counting instances in populations. Yin (2009) emphasises replication as an important part of this generalising to theory. Once theory has been developed, this theory can be tested in multiple case studies in which the theory should hold, and each replication builds the case for the soundness of the theory. Conversely, each failure to replicate represents a problematisation of theory that warrants investigation. In the present research, undertaking a nine participant, multiple case study method (rather than a single case study) allowed both replication between similar cases and contrast between cases that differ. This avoids the danger of putting “all your eggs in one basket” (Yin, 2009, p. 61) and enhances “the readers’ confidence that the findings are applicable to more than one case” (Henderson, 2007, p. 88).

Historically, the charge has been made that case studies are biased towards confirming theory (Babbie, 2017; Cargan, 2007). Flyvbjerg (2006) argues that case studies, far from being biased towards verification, are the type of studies in which subjects are prone to “talking back” (p. 20) to the researcher, undermining and problematising theories and presuppositions (see also Burawoy, 1998). The very nature of this research is designed to invite teacher knowledge enacted in real contexts to problematise both the empirically derived video design principles outlined in Chapter 3 and the aspirational knowledge frameworks advocated by Shulman (1986) and Mishra and Koehler (2006). This study presents evidence that suggests cases can indeed speak back to theory, testing the applicability of theory to real cases.

4.6 Methods of Data Analysis

This section outlines how the data collected using the methods outlined in this chapter were analysed to reveal meaning, keeping in mind the demands of establishing credibility, consistency, and transferability. Yin (2009) suggests that unlike statistical analysis, “there are few fixed formulas or cookbook recipes” (p. 127) to guide case study researchers when analysing data. However, he does suggest that “relying on theoretical propositions” underpinning the case study is “the first and most preferred strategy” (Yin, 2009, p. 130).

With this as a guiding principle, the data was initially analysed through the lens of teacher knowledge as outlined by Shulman (1986, 1987) when describing teacher knowledge, and the design principles outlined in Chapter 3 in order to code the ways teachers described effective videos. This approach does not imply that the teachers explicitly *knew* of the principles, or even mentioned them by name, but gave the researcher a structure to compare the knowledge of teachers to the literature base, providing a basis for analysis (Yin, 2009). These categories of teacher knowledge and design principles were used as an a priori coding scheme. Coding here refers to the tagging of qualitative data points with a descriptive label.

This theory-driven coding was complemented by the constant comparative method (Boeije, 2002; Glaser & Strauss, 1968), an analytic process born out of grounded theory. The goal of constant comparison is “to discern conceptual similarities, to refine the discriminative power of categories, and to discover patterns” (Tesch, 1990, p. 96), while also describing and conceptualising “the variety that exists within the subject under study” (Boeije, 2002, p. 393). The constant comparative method requires the researcher to compare each new data point to all of the available codes, adding or altering codes throughout the process until all the data can be accommodated, first within each case, then between cases. And “even then the categories remain flexible working tools" (Tesch, 1990, p. 96) throughout writing, with the codes serving the analysis, rather than driving it.

This iterative coding process was facilitated by the use of NVivo (version 12) software. All of the interview transcripts, observation notes, and correspondence collected during the data collection phase were imported into the software for coding. While all data were coded manually, rather than using the automatic functions available in the software, it allowed the researcher to easily compare the various data of one participant, or compare data between participants, an important aspect of the constant comparison method (Boeije, 2002).

Beginning by coding data to the categories for each of Shulman's knowledge types (see Section 2.1), new codes were developed or existing ones revised by the researcher when new data did not fit the existing codes. These new codes included concepts such as teacher search strategies; time constraints; level of collaboration; and considerations of classroom control. These codes tended to concern matters of implementation and context, and are primarily discussed in Chapter 7. The resulting "code tree [acts as] the beginning of the process of conceptualisation" (Boeije, 2002, p. 397). This meant that additional themes were allowed to surface, problematising a view that teacher knowledge was enough to explain the selection and use of instructional videos. The following chapters present the results of this analytic process.

4.7 Conclusion

This chapter has outlined the multiple case study methodology and design adopted by this research study, and the ways in which the resulting data set was analysed. This study adopts a worldview based on pragmatism and the state-of-the-actual, and a methodology divergent from much of the literature on effective design and use of instructional videos. Particular care has therefore been taken in the design of this study to establish trustworthiness and credibility through data triangulation, the presentation of abundant interview data, and coding based on the theories to which the study seeks to be analytically generalisable. In preparation for the presentation of the results of this data analysis (Chapters 6 and 7), the next chapter situates the study in its particular context through a description of the two sites, and introduces the nine participants.

Chapter 5: Case and Context - Introducing the participants

This brief chapter introduces the nine teacher participants and describes the two suburban secondary school contexts in which they taught. Despite the similarities that emerged in the teachers' practices, each certainly acted with a large degree of autonomy. As such, definition of a case in this study was that of the individual teacher (see Section 4.2.3). As will become clear however, these cases were not always easily bounded, or "fenced in" as Merriam (1998, p. 40) suggests a case should be. Rather, their practices, and the influences on these practices in terms of school identity, interactions between participants, personal experience and teaching experience were "difficult to unknot" (Phillips, 2014, p. 147) and at times directly "dialogical" (Phillips et al., 2016, p. 3031). Indeed, there were contexts that bound their practice that not all participants were aware of, such as the use of similar platforms, and common constraints on their teaching practices. These are discussed in greater detail in Chapters 6 and 7. While each teacher will be considered a case, it is still appropriate to describe them within the context of their respective schools, as the available technology and dominant culture at each school at times acted as a direct influence on the practices of the teachers, when choosing and using instructional videos.

Throughout this chapter, school specific statistics are rounded to avoid identifying the school with precise figures, and pseudonyms are used both for the participants and the schools. Data from interviews and observations are referenced as (I1) or (I2) for first or second interview with any given participant, and (O) for the observations. Personal communications via e-mail are referenced as “personal communications” with the date in day/month/year format. Videos used by teachers are given a code (V1-V58) to allow easy reference to the data on Appendix G.

5.1 Station College

Station College is a Catholic co-educational secondary school in Melbourne’s South East. At the time of data collection, it had a teaching staff of just under 70, catering to the educational needs of just under 700 students. It is characterised by a multicultural and diverse student population, where over 40% of students come from families with a language background other than English (ACARA, 2018). While in the past the school had a student population in excess of 1000, demographic challenges and local competition had led to a decline in enrolments that was improving at the time the data was collected.

The participants in this study expressed a fondness for the school and each other, and regularly expressed confidence in school leadership. This was particularly true of the principal, who was described by experienced teacher Margaret as “a good man, who cares for his staff” (I1). While the staff interviewed for this case study had mixed perceptions regarding the impact of technology, they agreed that effective use was modelled by leadership and were confident the school was on a constructive path to technology integration. This commitment to technology integration was shown in recent upgrades to school infrastructure such as improvements to wireless connectivity, introduction of wireless projection including screen mirroring, and upgrades of teacher laptops.

5.1.1 Introducing the Participants

At Station College, four teachers - Margaret, Helen, Dennis, and Carl - agreed to become core participants in the study, meaning they each engaged in two interviews, a classroom observation, and substantial e-mail communication. The data collection phase at Station College occurred over the course of third term during the 2018 school year. As was intended in the sampling advice given to the school principal, the core participants from Station College varied widely in teaching experience, perception of technology, and use of instructional videos. This task of inviting participants was delegated by the school principal to the e-Learning coordinator at the college. This coordinator successfully recruited three participants, Margaret, Dennis, and Helen. The final participant, Carl, was recruited by Dennis after I suggested an early career teacher would provide another perspective. Table 9 outlines the demographic data of the six participants from Station College. Brief descriptions of the core participants follow.

Table 9:

Participant Demographic Data, Station College

Alias	Gender	Years Teaching	Curriculum Focus	Role
Dennis	Male	25	History	Deputy Principal, Learning and Teaching
Margaret	Female	40	English, Religious Education	Classroom teacher
Helen	Female	27	Science, Mathematics	Classroom teacher
Carl	Male	2	Business Studies, Economics	Classroom teacher

5.1.2 Dennis

Dennis was Deputy Principal, responsible for the learning and teaching direction of the college, and had 25 years' classroom experience. He was a leader in the use of educational technology and put this into practice in his classroom role as a VCE History teacher. A "lover of technology" (I1) who had completed a master's degree in educational technology early in his career, Dennis had successfully advocated for improvements to the school's ICT infrastructure and staff technology. Dennis was often cited as a leader in educational technology by the other participants, such as Margaret who said "he is very good with IT, so he can see the potential of it" (I1) and Carl who said "he's really driving quite hard to update our backend systems, and implementing a lot of online learning tools" (I1).

Dennis discussed five videos he used in his teaching practice, four from YouTube, and one from ClickView. He tended to favour longer documentaries than other participants, such as an episode from a PBS series called *The People's Century* (V18), which ran for 53 minutes. This series was in Dennis's opinion "just about the best" (I2) and he suggested that these made-for-television documentaries were often "much better quality and more engaging than the ones that are produced for schools to use" (I2). When selecting videos, Dennis preferenced those with historical footage and engaging visuals and in this way likened them to the experiential learning gained from an excursion. He derided lecture capture videos, drawing on his past experiences with students, suggesting "if you've got a whole lot of talking heads without any source of footage then it's not going to engage students" (I2). He was also careful to find video material that did not stray too far out of the time span of history in his specific teaching aim. This constricted timeline reflected Dennis's deep knowledge of the mandated VCAA curriculum for the course, which dictates that this unit is bounded by the years 1945-2000.

Dennis was convinced that videos should be integrated into lesson plans, used as discussion starters or analysed as historical documents, rather than watched in isolation. This was reflected in his classroom practice, which is described in detail in Section 6.5.4. He reported that he would like to investigate the use of interactive videos, but struggled to find the time among “everything else” (I2).

5.1.3 Margaret

Margaret was the most experienced teacher in this study, with over 40 years in the classroom, mostly teaching English and Religious Education. She expressed that the pace of technological change in the profession was at times daunting, and that sometimes those who were less tech savvy were “being left behind” (I1). Keen to make it known she was “not a technophobe” (I1) Margaret suggested that she was improving her technological knowledge with the help of her tech able colleagues, by asking them to explain how to use new technology one-on-one. Margaret valued both of the subjects she taught, but a feeling of responsibility to teach Religious Education in accordance with Catholic tradition emerged as her “big number one” (I2) priority. She saw this as a “real responsibility at a Catholic school” (I1) and rated her content knowledge in that domain as “up near the ten” (I1) on a hypothetical ten-point scale.

Margaret discussed three videos she used during the data collection period, all sourced from YouTube. Drawing on what Shulman (1987) termed knowledge of learners developed over her career, Margaret believed she could anticipate the misconceptions students might have in a way that the video producers could not or need not, and used this to interrupt the playback accordingly to check understanding. In this way, she thought that much of the time, students watching YouTube videos on their own would be less effective. Drawing on changes she had seen over her career Margaret claimed “I've been teaching 40 years now and with the onset of devices and clips and you know Instagram and all those things they're very used to this quick view of the world… so therefore if we can utilize some of that in the classroom it just keeps the attention going” (I1). Margaret was quick to affirm that she could teach the content on her own, but used the videos to inject variety. This was shown by Margaret’s decision to reject usage of the EdRolo platform (a subscriber-based VCE lecture video provider) in her teaching of senior English. She argued that from her experience, and knowledge of curriculum, the EdRolo presenters were advising students contrary to best practice.

5.1.4 Helen

Helen was a Science and Mathematics teacher with 27 years of teaching experience, but had only been teaching at Station College for two years. She exhibited well-developed PCK both in conversation and during the class observation. She demonstrated a range of “analogies, illustrations, metaphors, examples that take into consideration differences in students’ abilities” (Wilson et al., 1987). She was easily able to transform the conceptual mathematical theories she was teaching into real world examples to motivate students, and had a ready answer for students who suggested they were innately poor at science. In the classroom Heather was observed to be calm, controlled and knowledgeable in her interactions with students, utilising both hands-on exploratory learning and direct instruction. Despite being ambivalent about her own technological knowledge, Helen was able to quickly solve three technical problems that arose in her class without fuss.

While Helen argued that in Science, hands-on learning was always preferential to learning from a video because she believed “it’s the experiences you remember” (I2), she saw the value of videos in terms of safety, engagement, and flexibility. Helen's primary use for videos was to display phenomena that were "beyond the risk factor" (I1) or impractical in the classroom. Examples she mentioned included explosive chemical reactions, lab safety equipment, and teaching about internal body systems, "because nobody is going to give me half a dozen cadavers for the kids to play with" (I2). YouTube was Helen's first port of call when searching for videos. Indeed, 8 of the 10 videos Helen reported using were sourced from YouTube. If she found that the videos she considered "ho hum" (I2) she turned to ClickView. While initially she suggested she "would look at a colleague's YouTube channel first" (I1) it later became clear when asked to navigate to the channel page that she had not used any of his videos, nor in fact was she sure what his channel was called. This divergence between initial representation of process and the reality existed for many of the participants.

5.1.5 Carl

Carl was an early career Business and Economics teacher in only his second year of teaching. Despite his relative inexperience, Carl had been trusted with teaching two senior VCE classes, including a Year 12 Business Studies class. In terms of his content knowledge, he rated himself "at the lower end, I'm just getting started" (I1), and throughout the interviews and observations, it emerged that Carl had a limited pedagogical vocabulary to explain his actions in class. Carl reported that he had high technological knowledge (TK), describing himself "as a bit of a YouTuber" (I1) in that he watched videos on that platform at home extensively and thought it was "amazing" (I1). He suggested that while other teachers struggled to keep up with technology, he embraced it. Carl's preference for YouTube was evidenced by the fact that nine of the ten videos he reported using during the data collection period were sourced from that platform.

In the classroom, Carl tended towards a direct-teaching method, relying on PowerPoint presentations and direct instruction. He used videos often “as a starting point to lessons” (I2) or to illustrate concepts, but rarely paired these with learning activities, citing a lack of preparation time, saying “I haven’t created a lot of worksheets to answer and things like that but if I had the time I would like to” (I2). Indeed, Carl admitted rarely having time to watch the videos he showed in class prior to lessons.

5.2 Wayfarer College

Wayfarer College is a large, multi-campus Catholic coeducational secondary school in Melbourne’s outer-east. It has a teaching staff of over 200 catering to the educational needs of just under 3000 students, evenly distributed between girls and boys. It has seen rapid growth both in buildings and student population, growing by more than 700 students between 2015 and 2019.

The ICT infrastructure at the College is exceptional, with participants universally reporting the internet connection as strong and reliable, and IT support as responsive and effective. School leaders are supportive of staff using technology, and invest in this area of school life. Indeed, the school had recently invested in new virtual reality headsets for students and Alison said “it would be hard to ‘get around’ IT more than this school does” (I1). Louise recalled that in the past the internet was unreliable enough that it would affect her planning, but that she had “not had any problems for the last two years” (I1).

All students at Wayfarer are required to have a personal digital device. Because it is a multi-campus school, teachers are supplied with the Microsoft Teams program to communicate with colleagues both asynchronously and synchronously, using subject channels and chat functions. That said, Troy suggested that for everyday purposes, he found that resources such as videos and learning objects were more often shared in chance face to face meetings with campus colleagues.

5.2.1 Introducing the participants

Five teachers agreed to participate in the data collection phase from Wayfarer College – Melissa, Troy, Alison, Louise, and Lucy. They each engaged in two interviews and a classroom observation, and exchanged multiple e-mails with the researcher, including a follow-up series of questions one year after data collection. The task of inviting participants was delegated by the Principal to the Vice-Principal, Learning and Teaching. As requested, he invited a wide variety of participants in terms of teaching experience, approaches to technology, and subject domains. Of the 6 teachers the Vice-Principal invited, 5 agreed to become participants in the study. The demographic profile of these participants is outlined in Table 10. Brief descriptions of the participants follow.

Table 10:

Participant Demographic Data, Wayfarer College

Alias	Gender	Years Teaching	Curriculum Focus	Role
Lucy	Female	30	Art	Year 9 Coordinator
Troy	Male	6	Science	Year 7 Coordinator
Melissa	Female	2	History, Religious Education	Classroom Teacher
Alison	Female	1	English, Religious Education	Classroom Teacher
Louise	Female	16	Mathematics, Science	Year 7 Coordinator

5.2.2 Lucy

Lucy was an accomplished art teacher, with 30 years of classroom experience and formal training in visual arts. In addition to her role teaching junior Art, she was also the Year 9 coordinator at one of the Wayfarer junior campuses and had an advisory role on the college e-learning committee. A self-described "lifelong learner" (I1), Lucy took three weeks of annual leave during the data collection period to complete further study in education toward a master's qualification.

When discussing her TK, Lucy described herself as "a bit of a gadget freak," and that if teachers "don't get their heads around technology then you're going to be left behind" (I1). This was reflected in her practice, as she effectively used various platforms such as Microsoft Sway, the school intranet, and Khan Academy to share and collect work from students. As a teacher, she was observed to be well organised and in control of her classroom. Lucy self-reported a high level of content knowledge, saying there were very few questions a junior art student could ask that she would not be able to answer (I1). It was clear through the resources she created, and the critical way she approached various technologies, that Lucy was a confident practitioner.

Lucy discussed four videos she used during the data collection period, all of which were sourced from YouTube. Three of them were live action how-to videos designed to demonstrate artistic procedures. The other video Lucy used was a talking head style, introducing the artistic concept of appropriation that was shared with students via a Microsoft Sway document in a flipped learning context, showing an exploration of the particular affordances of video based learning.

Lucy saw the advantages of videos to her teaching practice in terms of presenting a variety of perspectives, engagement, efficiency, and student autonomy. Lucy spoke regularly of the videos "inspiring" (I1) students or motivating students' "thinking about what they can do" (I2) in their art. Lucy aspired to record her own videos in order to achieve an even higher level of student autonomy and efficiency, because:

> we spend a lot of wasted time going over and over at the techniques they don't remember but if we all got into the habit of videoing all of those demonstrations, and putting them where these students could access them that would save everybody a lot of time that's what I would love to see. (I2)

One year after this interview, Lucy reported that time constraints continued to prevent her department from making these videos, emphasising the centrality of labour demands in teacher enaction of knowledge (see Chapter 7).

5.2.3 Troy

Troy had been teaching Science for six years, and also held the position of Year 7 coordinator at one of Wayfarer's junior campuses. Uniquely in this study, Troy ran a YouTube channel with almost 6000 subscribers and 850,000 views as of April 2020, from which he generated a small monthly revenue. This channel emerged as an important part of his identity as a teacher, and he was proud of the fact that his colleagues, students, and many viewers from around the world found his videos helpful.

Showing that CK can be unevenly distributed across a subject domain, Troy reported at times teaching in his "own little niche" (I1) of biology and psychology in which he majored at university, but just as often teaching in strands of science that were less familiar to him like geology and physics. This was borne out during observation, in which he happily admitted being unable to answer a student's question about velocity because "I'm not up to that high-level physics" (O). Troy was less likely to use a video, and more likely to run a practical activity, in a lesson for which his content knowledge was better developed. For example, he reported being the only Year 8 Science teacher to elect to run a brain dissection with his class despite having made a YouTube video on just that topic. In contrast, Troy described searching for videos to use in class to explain topics outside of his area of content expertise, such as tectonic plate movement.

Troy reported having high TK, mirroring Lucy's comment, saying education was "at the point now where you have to love it, you have to embrace it otherwise you just get left behind" (Troy I1). Despite his love for technology, Troy used a fairly teacher-centric pedagogical style in his classroom. This was borne out in the fact that he showed all of his videos on a projector in class so “I can ensure that all of them have watched it and all of them are paying attention” and so “I can pause it at certain times too and dissect certain pieces” (I1).

Troy discussed six videos he used during the data collection period, all bar one (V56) of which was sourced from YouTube, with the remaining video sourced from a colleague as an mp4 file. Like the other science teachers in this study, Troy cited the ability of videos to display phenomena at a scale and safety level otherwise impossible as their key affordance. Echoing a theme that emerged as important in the data (see Chapter 7), Troy reported his perceived busyness and need for efficiency as an important factor in his selection and use of instructional videos.

5.2.4 Melissa

Melissa was a History and Religious Education teacher in only her second year of teaching. She taught 8 separate classes, including a History unit that had no textbook or curriculum document, in which her teaching teammate was a graduate. Despite this daunting load, Melissa’s outlook was optimistic. When discussing History, she was passionate and confident of her PCK, often researching deeply the topics she was asked to teach. In terms of TK, Melissa suggested that she preferred “handwriting things and things that aren’t on a device” (I1), and while she did not shy away from it she did not have “a pizazz for it” (I1). Melissa used videos less frequently than the other teachers in this study, to the extent that in the three weeks between our two interviews, she did not use any instructional videos across her eight classes.

Melissa did, however, discuss five videos she had used prior to our interviews, and one she was planning to use in the week following her second interview. Of these, five were sourced from YouTube and one came from the ABC Q&A program website (V49). This was despite her suggestion that when searching for videos “I would usually start” with ClickView because “I like the feature of being able to put in questions” (I1). When later asked for any examples of videos she had enhanced in this way, Melissa reported “I don’t remember which video I added questions to” (Personal Communication, 15/10/2018), and suggested it was not a common practice.

Despite a general preference for non-digital teaching materials, Melissa demonstrated a nuanced understanding of video affordance, primarily in terms of breaking through student apathy by “helping them make the connection between what they've read and the reality” (I1). This was particularly true in her use of a TIME video called *The Body of Emmett Till* (V48) which elicited a “gut wrenching reaction” (I1) while reinforcing content knowledge, after which Melissa said “they cared” (I1). This shows Melissa’s tacit understanding of CATLM (see Chapter 3) which emphasises the role of affect in creating “the internal state that initiates, maintains, and energizes the learner’s effort to engage in learning processes” (Mayer, 2014c, p. 171).

5.2.5 Alison

Alison was a young graduate teacher, in her first year of teaching junior English and Religious Education classes, despite having a major in History. Like the other teachers of English, Melissa and Margaret, Alison expressed a preference for pen and paper over technology - “English teachers, we’re paper people, we love it” (I2). Despite this, she rated her TK as medium to high, and suggested that “when shown how to do something” then “one hundred percent I’ll be ok” (I1). Alison’s focus was on engagement and strict classroom management in her graduate year, and she reported feeling under extreme time pressure.

Despite her preference for pen and paper, Alison discussed five videos she used during the data collection period, four of which were sourced from YouTube and one was stored on the school intranet. Alison saw the value of videos primarily in terms of engagement and student preference, suggesting a less-developed TPK than some of the other participants, which is consistent with Shulman's (1986) argument that teacher knowledge develops with experience. This was particularly true in her Religious Education classes about which she reflected that "the kids aren't generally engaged" (I1) and without videos "they don't want to know about it" (I2). Alison admitted that teaching Religious Education was "unfortunately not my priority" (personal communication, 21/2/2020) and rated her content knowledge lower in that domain. Because of this, Alison saw the videos in Religious Education, particularly one on canonisation, as a source of knowledge for herself. This echoes Troy's perception that videos are an efficient way to teach content when the teacher themselves lacks the knowledge to do so. Alison said there was less need for videos in her English classes because the "different learning activities keep them engaged instead," suggesting she had a greater range of pedagogical representations and strategies in English than for RE. Regardless, she still used instructional videos to supplement her own knowledge, saying ClickView had "a lot of Shakespeare resources on there which were really helpful for me going into Romeo and Juliet and I thought I'd use a lot of it for the kids but I didn't actually need to, it was more useful for me" (I1).

The central frustration of finding an effective video in Alison's judgment was that "unless you make it yourself you can't ever get the exact right content for that class specifically" (I2). Demands for specificity and cultural appropriateness meant that searching for content did not, in Alison's opinion, represent a positive cost benefit proposition in terms of labour and time.

The same reason was cited as to why she had not yet created any enhanced videos using ClickView, which she aspired to do, but could not find the time.

5.2.6 Louise

A Science and Mathematics teacher with a content specialty in Biology, Louise had been teaching for 16 years, and was also a Year 7 coordinator at one of Wayfarer's junior campuses. Louise had previously held the position of e-learning coordinator and considered herself to have high TK. She had a master's degree in ICT in education and was a confident communicator both in the classroom and in interviews. While Louise had created videos in the past, she stopped doing so when the school subscribed to a differentiated mathematics platform that included targeted videos, citing efficiency as an important reason for that change in practice.

Louise discussed seven videos she used during the data collection period, six of which were sourced from YouTube. Louise reported that students in her Year 7 Mathematics classes used many videos through the differentiated maths platform *Maths Pathway* (V37) while working through the course at their own pace. In order not to skew the data, one video was chosen as representative of this teaching method. This decision was made because Louise herself rarely chose the videos on the Maths Pathway platform, instead they were more regularly suggested for the students by the platform based on their progress.

Displaying nuanced TPK with regard to instructional videos, Louise saw a variety of roles video played in her pedagogy. Like the other science teachers in this study, Louise explained that videos allowed her to display phenomena that were unsafe or at too large a scale to conduct in class. She cited both the "microscopic things that we don't have the equipment for" and the large "tectonic plate movement" (I1) as phenomena that video was adept at displaying.

She also identified the role videos had in releasing her from the traditional teaching role of lecturer.

In her Mathematics class, a group she called “brilliant,” she allowed most students to watch videos on their own devices from the Maths Pathway platform, allowing her to gather “a group together that I know we're struggling on a particular concept because they hadn't mastered it” (I1). Prior to the introduction of this platform, Louise “felt like I wasn't able to go back with those kids and teach them the basics properly before the topic ended and I had to get a test in” (I1). In fact, she said it meant she needed “to have a really good broad understanding of the curriculum in maths” (I1) because students were working anywhere between level four and nine. While this class was fascinating, and perhaps deserves a more focused study, it represents an atypical pedagogical approach outside the bounds of this study. In order to consider more deeply typical classrooms, Louise’s single self-directed Mathematics class will not be considered further in the data analysis.

5.3 Conclusion

This brief chapter has provided descriptions of the participants and the schools in which they taught. The teachers represent a wide range of experiences, subjects, and approaches to teaching and as such can be said to afford a certain degree of variation (Merriam, 1998), which will be explored more fully in the next two chapters. In this chapter the participants are treated as separate cases, whereas in the next two chapters these cases will be compared and synthesised in order to investigate trends in teacher knowledge use.

Chapter 6: Teacher knowledge and video use

The previous chapter introduced each participant as a series of nine independent cases from two school contexts. This chapter investigates the commonalities and trends in teacher knowledge and practice that emerge when the cases are considered together. As discussed in Section 4.2, differences and commonalities between and among cases afford opportunities to develop theoretical and empirical conclusions through what Yin (2009) calls both literal and "theoretical replication" (p. 138) – in which differences between cases support theory. Findings are presented in this chapter under the headings of knowledge types that emerged as particularly important during analysis. This is not to say that those knowledge types without dedicated sections were not drawn on, but that those selected for deeper discussion were foregrounded in the decision making of these nine teachers. This approach foregrounds the main research question concerning *how teachers select and use of instructional videos* and the first subsequent question dealing with the impact of teacher knowledge in this process.

The boundaries of this study mean that it focuses on the selection and use of resources that can be considered a digital technology, namely instructional videos. Because instructional videos and the technology used to show them have largely become ubiquitous tools in mainstream education (Langworthy, 2017; Poquet et al., 2018) and in this study the teachers treated them as technologies towards the transparent end of a sliding scale of educational technology (Cox, 2008; see Chapter 6.4.1), in most cases Shulman's (1986, 1987) knowledge base for teaching is sufficient for describing much of the knowledge teachers drew on. However, at times, teachers were more conscious of technology, for example, when considering the affordances of instructional videos as compared to other representations, or reasoning through the particular technologies they might use to display or enhance videos. In these instances, the technological aspect of their knowledge was foregrounded and Mishra and Koehler’s (2006) framework is employed as an analytic tool.

Mishra and Koehler (2006) argued that separating teacher knowledge into its constituent elements “is an analytic act and one that is difficult to tease out in practice” (p. 1029). They went on to argue that “viewing any of these components in isolation from the others does a real disservice to good teaching” because of the “dynamic transactional relationship” between knowledge types (p. 1030). This interconnectedness of the teacher knowledge base emerges in the analysis in this chapter, and as such structuring it has involved a process of balancing a representation of the “messiness” of teacher knowledge, and the demands of readability. Therefore, while knowledge types are presented in discrete sections, the connections between them are discussed regularly.

As an analytic device, the knowledge used by participants was compared to the theoretical knowledge base outlined in Chapters 2 and 3 in order to investigate whether the literature on effective use of instructional videos accurately depicts the state-of-the-actual (Selwyn, 2008). Given that none of the participants, beginning or experienced, reported having any explicit knowledge of video design literature, similarities may be evidence of either tacit knowledge, or a confluence of episteme and phronesis (Eisner, 2002). Differences may represent areas of potential improvement for teacher preparation courses, or alternatively highlight areas of conflict between experimentally derived principles and classroom practice.

This apparent reality that teachers drew almost exclusively on the wisdom of practice surprised me. In order to confirm this, following Yin’s (2009) focus on triangulation, a year after the initial data collection the teachers were asked in the questionnaire (see Section 4.4.4) to reflect on the sources they drew on when forming professional judgements about instructional video use. The responses were remarkably consistent:

> I base these criteria on my years of experience in the classroom and feedback given to me by the students in my classes over the years. (Louise, personal communication, 22/9/2019)
>
> I've learnt just based on my own experience watching YouTube clips and gathering responses from students in the classroom. (Carl, personal communication, 8/10/2019)
>
> Only basing this on my professional experience so far! (Alison, personal communication, 1/10/2019)
>
> Mostly wisdom of practice (Lucy, personal communication, 7/10/2019)
>
> I haven't actively searched for a theory in regards to this, but based a lot of my "thought" on personal experience as a student and observations of my classes. (Melissa, personal communication, 19/1/2020)
>
> Again, more 'wisdom' – don't think I've ever read anything about pedagogy of videos, but it could easily be adapted from Bloom or Gardiner in terms of what is required to scaffold from understanding through to creative thinking and engagement. (Dennis, personal communication, 30/9/2019)

> Yes, it is experience. It is observation and understanding how my students learn. (Margaret, 16/9/2019)

> Creating short and concise videos is line with how I teach - I like to get straight to the point and teach the essential content that they need. I'm also mindful of adolescents' attention spans which, from my own experience, is fairly small! (Troy, personal communication, 7/10/2019)

> Sorry, I cannot really tell you. I think it is a learned art, which is where newer teachers watching already selected clips until they get a feel for it helps. (Helen, personal communication, 11/9/2019)

The themes and commonalities in this chapter and the next emerged as a result of an iterative process of coding and recoding described in Chapter 4. Coding followed the constant comparative method outlined by (Boeije, 2002), using Shulman’s knowledge types and the CLT/CTML principles as an *a priori* coding structure. In this chapter, four knowledge types emerged as particularly influential on teacher selection and use of instructional videos:

1. knowledge of learners and their characteristics (Section 6.1)
2. curricular knowledge (Section 6.2)
3. content knowledge (Section 6.3)
4. PCK and to lesser degree TPACK (Section 6.4)

Factors influencing teacher practice that could not be coded into the a priori categories, such as identity, time pressures, and the influence of algorithms, were created as new codes.

These factors are discussed in Chapter 7 and highlight the reality that while knowledge accounts for much of a teacher's practice with instructional videos there are contextual factors that contribute to teacher action that exist beyond knowledge.

6.1 Knowledge of learners and their characteristics

When selecting materials that they believed were likely to lead to effective learning, the teachers in this study drew heavily on what Shulman (1987) labelled "knowledge of learners and their characteristics" (p. 8). Analysis of the data revealed four key ways in which this knowledge affected teacher selection and use of videos.

First, knowledge of a general student preference for videos over static texts and their role in increasing engagement were reported as reasons teachers initially chose to use videos. This consideration, while emerging from wisdom of practice, offers support for Plass and Kaplan's (2016) integrated cognitive model of learning with multimedia (ICALM, see Section 3.4), in that the teachers saw videos as having a positive attributed affect on student motivation.

Following the decision to use a video, teachers used knowledge of learners to select particular videos that embraced, or at least did not violate the social mores, of the student culture (see Section 6.1.2). CTML has as a central principle the active processing assumption (Mayer, 2014b) which rejects the idea of humans as passive receptors of information, but instead recognises that learners make active decisions as to what details in a presentation (if any) to attend to. The teachers in this study saw the necessity to select videos that students would be willing to watch, rather than those they might find boring or "cringe-worthy" (Troy, I2).

Next, while selecting videos, teachers took into account their understanding of student prior knowledge in order to avoid overloading the cognitive capabilities of learners, showing a tacit understanding of the limited capacity assumption (Mayer, 2014b). Finally, drawing on their own wisdom of practice concerning the characteristics of their learners, most of the teachers in this study had rejected the pedagogical approach of the flipped classroom. For many, this was because students often failed to watch the videos at home, while for Dennis, it was based on an understanding of the affordances of physical classrooms. These four themes are explored in the following sections.

6.1.1 Student engagement with and preference for video

The teachers in this study variously described the captivating nature of instructional videos in general as “the wow factor” (Helen, I1), “entertaining” (Lucy, I1; Margaret, I1), and “engaging” (Troy, I2; Carl, I2; Dennis, I2; Melissa, I2). Alison explained that in Religious Education, “the kids aren’t generally engaged so videos are really important” while in English she did not need to use a video because “we’ve got different learning activities that keep them engaged” (I1). This suggested a role for videos in making what the teacher deemed uninspiring, or what they felt they could not make exciting on their own, more engaging. While not mentioned by all, six (Alison, Helen, Margaret, Lucy, Louise, and Carl) of the teachers expressed a belief borne out of experience that their students in general preferred video over text, and that this preference guided their decision to use videos more often in class.

Asked how she would respond to a hypothetical critic who said videos were a waste of time, first year English and Religious Education teacher Alison replied “I would say ‘have you been in a classroom? Have you met these kids?’ Because they don't really want to read a book. They don't want to read an article. They’d rather watch it on a screen” (I1). In her second interview, Alison was even more direct, making the rather sweeping statement that “all the kids love a video all the time" (I2). At Station College, Science teacher with 25 years' experience Helen made a similar statement, showing that this student preference for video delivery was likely not an artefact of location or experience. Speaking about her justification for a class activity during the observed class in which students watched a video on digestion while completing a worksheet, she explained:

> The reason I wanted them to look at the video was because most of them won't read the textbook. I provided them with the booklet of worksheets today, which they could easily do by looking up the textbook which tells them the answer, but they won't, period. Even if I set it for homework I'll have maybe a fifty percent uptake, whereas now they've watched that video if I go to them 'ok how much of this worksheet can you do before the end of the lesson' at least some of that information will be there and some of them might go back and scan through the text book. But they are not, most of them not, readers of the textbook. (Helen, I2)

While she tempered her view slightly, saying 'most of them' are not readers of the textbook, the practical application of the belief was the same.

As the most experienced teacher in this sample, Margaret (40+ years) reflected that student preference for videos had grown with what she perceived as a change in the way students process media, and that as a result videos were useful in capturing student attention:

> I've noticed, cos I've been teaching 40 years now, that with the onset of devices and clips and, you know, Instagram and all those things, that are they're very used to this quick view of the world of things and they use more than one sense, more than just their hearing is being utilized. So therefore, if we can utilise some of that in the classroom it just keeps the attention going. (I1)

Margaret recognised that students were “very used to” multimedia, and was of the opinion that the multi-sensory nature of these media meant that teachers needed to “utilise some of that in the classroom” lest they lose the attention of students.

Other teachers agreed that a reliance on direct instruction or static images was likely to lead to student disengagement. Art teacher Lucy explained that using a video “with amazing graphics and great examples” (Lucy, I1) was, in her judgment, “more entertaining than me standing up with a single slide on the projector saying this is a Van Gogh or whatever”. This theme of instructional videos providing an alternative to the teacher’s voice was also picked up by Alison, Louise, Melissa, Carl, and Margaret, suggesting this tacit understanding persisted regardless of location or experience.

This perception of teachers that students tend to prefer video-based instruction over other instructional methods and that instructional videos increase motivation is consistent with other case study literature (see Table 1, Section 3.1.4). While increasing enjoyment has not always related to an increase in learning in the research (Castro-Alonso et al., 2019; Craig & Friehs, 2013; Muller, Sharma, et al., 2008), it is theorised that if the anticipated effort imposed by a learning task, as the teachers here suggest is the case when learning from static text, outweighs the perceived value of the task, students may opt not to engage (Wigfield & Eccles, 2000). The experienced Science teacher Helen summed up this sentiment when discussing the engagement value of instructional videos in general, saying “sometimes, you just need to make it fun and relevant – and yes they're going to learn something from it but they're more likely to learn something from it if they're not falling asleep on the back table” (I2).

It is important to note, however, that with the exception of Carl who said that he “could use a video for anything” (I1), the teachers expressed the view that videos led to student engagement in particular pedagogical instances, such as when the content was boring, when they had spoken too much, or when an affective connection with the material was lacking, rather than asserting a universal or constant impact. The collection of actual videos selected (see Appendix G) supports the idea that videos were used to supplement, rather than add, to talk time. For instance, of the 58 videos used by the teachers a relatively high number were visually complex, classified according Table 2 (Section 3.2.3) as infotainment (13), documentaries (12), and animations (8). In contrast, very few were classified as lecture capture (2), voice over slides (1), talking head (2), or interview (1). As such, the teacher perspectives and their video selection practices support the findings of Bunce et al. (2010) who unsurprisingly found that varied instructional approaches led to greater student attention when compared to a voice-dominated lecture.

The teachers in this study acted on their wisdom of practice that most learners tended to enjoy videos, and the understanding that they could build engagement when the content or alternative pedagogical options were likely to lead to boredom. This section has shown that the teachers drew on their knowledge of student preferences for multimedia to develop an understanding that instructional videos were valuable in providing variety and leading to improved student engagement. However, as the rest of this chapter will reveal, simply showing any video was not enough to achieve the pedagogical aims of the teachers. The selection and presentation of the particular videos were equally as important and were content and context (to draw on Shulman’s 1986 categories) bound.

6.1.2 Teenage culture and affect

When selecting particular videos to display to students, seven of the teachers in this study (Louise, Troy, Melissa, Alison, Carl, Helen, and Margaret) specifically mentioned drawing on knowledge of their students' age, culture, and tastes. More frankly, these teachers considered what students would find “cool”, or alternatively, “make them cringe” (Troy, I2). When describing pedagogical reasoning and action (PR&A), Shulman (1987) points to these kinds of cultural considerations, when he outlines the process of adaptation, by which teachers tailor teaching representations to the “gender, language, culture, motivations, or prior knowledge or skills” (p. 17) of particular students. He goes on to point out that these considerations extend beyond the level of the individual student to the dynamics of class groups and their “disposition, receptivity, and interpersonal chemistry” (p. 17). The data in this study suggests such considerations also apply to the selection of instructional videos.

Louise discussed the need for a video to not only engage the attention of students, but to avoid putting them off. She explained that when she was looking for videos for her Year 9 Science class:

> It can't be corny, especially at this age. I like Crash Course because he's quirky but not corny, like they don't sit there saying ‘that's embarrassing’ as teenagers. Bill Nye the Science Guy is another one but he's a little bit corny. (I2)

Interestingly, the word “corny” was also used by early career teachers Troy and Melissa when describing what to avoid. In Troy's case, he was describing exactly the same Bill Nye Disney series that Louise had mentioned. Troy had discovered that older students found Bill Nye's delivery style “cringe-worthy” (I2), but that is was appropriate for younger students. Troy only used the series in his Year 7 class because “Year 7s buy into it a little bit, the Year 8s fifty-fifty, but the year 9s just think it's ridiculous" (I2). Troy said he "learned this the hard way" (I2) with his year 9s, which suggests this knowledge of learners took the form of phronesis (Eisner, 2002) emerging from the wisdom of practice, and that the development of knowledge about student cultural preferences was, in Troy's case, an iterative process.

Similar to the need to avoid corny videos, graduate teacher Alison was at pains to find videos that were "not too churchy" (I2) when preparing for her Year 10 Religious Education classes, and even said that when she showed a video hosted by a "hip and handsome" priest, the students were "not interested" (I2) because of what she concluded was a cultural aversion to the Catholic priesthood. Again, this shows an iterative process of developing knowledge based on reflection on practice, a process by which teachers look back at teaching episodes in order to develop new knowledge (Shulman, 1987). Revealing that student culture is not universal but relative to the specific students and their context, at Station College, Margaret used a very similar video called *Sacraments 101* (V42) in her Year 8 class, but deemed it appropriate for her students, describing the priest as "cute and funny" (I1). She reported that the video was well received by students. Whether this was because of their age or the culture of the school or class is unknown.

Carl, in his second year of teaching, actively sought videos for his senior Business Studies class that featured pop or sports stars, and fashionable brands such as Apple, Samsung, or Nike that students were "big on" (I2). He described these popular culture references as what allowed students "to lock in" (I2) to material he might otherwise struggle to make engaging.

With regard to CTLM, teacher consideration of the culture of learners may be worth investigating as a cultural affect principle. This appears to be a type of violation of the coherence principle similar to seductive details (see Section 3.5.4.1), in that it introduces a factor that distracts or leads the learner to focus on tangential matters. If the presentation style is inappropriate enough it may cause a student to focus on their dislike for the medium rather than the message, particularly in students with low emotional self-regulation (Plass & Kaplan, 2016). Conversely, a particularly positive cultural fit, such as a celebrity presenter or favoured presentation style, may help motivate a student, which could help overcome other deficiencies in an instructional video. This is described in Section 3.4.2 as “attributed affect” in the ICALM (Plass & Kaplan, 2016).

When Mayer (2014c) proposed elements of multimedia that may build motivation and positive emotional responses he wrote of factors internal to the media, such as challenging examples, interesting illustrations, and colourful design. This has been replicated in experimental designs, whereby design interventions like drawing friendly faces on shapes (Chiu et al., 2020; Um et al., 2011) have led to improved transfer performance. The implication in the experimental and theoretical literature is that design elements can be found that increase interest all learners.

The data from the present study, however, suggests that the content of videos may be engaging and interesting to some students, but cringe-worthy to others. As was demonstrated by Alison’s priest example for her largely secular classroom at Wayfarer, it may be the case that pre-existing cultural biases or beliefs may elicit a negative affective state in some students but not others (such as Margaret’s at Station) when shown the same video. This is an area worth future investigation, as the level to which a presenter is “corny” or otherwise unpleasant in the eyes of a student may detract from learning either through distraction (following the seductive details effect) or negative affect (following the ICALM). At this stage, much of the experimental literature implies a ‘one size fits all’ view of instructional design. This view may be refined through considerations of the context-dependent knowledge of students demonstrated by the teachers in this study and proposed as important by Shulman (1987).

Such considerations, which were taken into account by the teachers in this study, touch on what Plass and Kaplan (2016) described as the central thesis of the ICALM, namely that "affective processes are intertwined with, and inseparable from, cognitive processes, and that the cognitive-affective processing of multimedia stimuli involves affective processes that make demands on cognitive resources" (p. 150). Data from this study indicates that many of the teachers involved in this research considered the role of student and class culture and it affects the kinds of videos they choose to show. The experiences of these teachers also show that the assumptions of what students are likely to enjoy, and it is necessarily a prediction until after the fact, is based on phronesis rather than any formal scholarship. In short, in order to choose effective videos for students, this study suggests that teachers are aware of student culture, and student reactions to prior examples. As shown by the disparity between the two schools, this knowledge is particularly context-bound, both in terms of institutional culture and age group within a particular institution.

This is a contribution of this study, both to Shulman's model, which did not describe the role of student culture in selection of learning materials, and to the experimental approaches adopted in CLT/CTML which could be improved through consideration of the role of learner culture at an individual level when measuring relative effectiveness of video designs. It should be noted, however, that codifying this form of knowledge may prove particularly difficult because understanding youth cultural preferences may be one the aspects of teaching that Eisner (2002) calls *artistry*. Beyond episteme and phronesis, these are the productive aspects of teacher knowledge "that follow no rule, they need to be felt" (p. 382).

6.1.3 Prior learning and overload

The teachers considered the prior knowledge (including literacy) of their learners when selecting videos with a view to avoiding overwhelming their novice learners. This consideration of comprehension and overload was particularly important for teachers of junior (years 7-9) classes and showed a tacit understanding of the concept of cognitive overload (see Chapter 3).

As a teacher of junior Science, Troy explained that when he searched for videos an important concern was to ensure that the videos “don't go into more detail than we need in the class, what the kids need, and overwhelm them - just some of them are aimed at VCE [senior] level” (I2). He went on to explain that he sought “clarity, keeping it concise and in as simple terms as possible” (I2). Troy’s use of the word “overwhelm” shows a tacit knowledge of a key premise of CLT/CTML, that is that the complexity of learning material should depend on “how much someone already knows about the domain in which the information will be situated” (Reedy, 2015, p. 356) so as to avoid cognitive overload.

Lucy exhibited very similar reasoning in Art, a very different subject domain to Troy’s Science class. Describing her reasoning for choosing a video entitled *23 Amazing Sculptures You Won’t Believe Exist* (V39) to introduce sculpture to her Year 7 Art class, Lucy reasoned:

> If I had gone on to the Khan Academy site I could have found a video on Rodin or that sort of sculptor video, but it would have been totally above their heads. It might have been suitable for a Year 12 class who were studying sculpture, but for Year 7 they just need the fun ones. Information, inspiring, and short… You could have some high academic talking about those sculptures but that wouldn't resonate with these students. The fact [was] that she just plainly gave a little bit of information about the working of the Sculpture. (I2)

The two themes of comprehension and affect were enmeshed in Lucy’s reasoning. She rejected the Khan Academy videos because they would go “over the heads” of her students, while the one she chose delivered “a little bit of information plainly.” However, equally important to her was that excessive complexity might lead to disengagement. Lucy expressed an understanding that complex material threatened both cognitive overload, but also boredom in her novice Art students.

These two examples reflect similar views expressed by Carl who avoided lecture style videos for his class that consisted of students with lower literacy levels (I1), and illustrates the ways in which these teachers drew on their knowledge of the particular learners and their prior knowledge when choosing videos. Teachers compared their internal model of their students’ prior knowledge to the information presented in the video. If the video was pitched beyond what the teacher deemed the student could comprehend, the video was rejected. There was a frustration that videos on topics the teachers were required to teach were often “aimed at VCE level kids” (Troy, I2), and presumed greater prior learning, particularly for junior students.

6.1.4 Flipped learning

All of the teachers in this study had knowledge of the flipped learning pedagogical approach in which students are set videos to watch prior to class (see Section 3.1.2) but most expressed some scepticism as to its effectiveness, based on their knowledge of learners. All four of the early career teachers, defined by ACER as the first six years (Weldon, 2016) (Carl, Alison, Melissa, and Troy) had been exposed to flipped learning in their initial teacher training. Lucy reported that “flipped classroom is something a lot of educationalists are talking about” (I1), demonstrating the extent to which the practice has become mainstream in educational discourse

(Baggaley, 2015) if not in practice. Both Dennis and Margaret suggested that flipped learning had been discredited as a method, and had largely dismissed the method in their own practice. Dennis explained:

> The most recent research has talked about flipped learning not actually being all that educationally effective because it relies on a certain degree of student competence already existing. So, for those students who might be in that lower middle or lower educational aptitude, it's not useful to them because if they haven't understood the first part of a video they're already lost, the rest of what they're doing is lost. And that means how can they actually learn or do the homework? That's where in a classroom situation the teacher is able to intervene and know exactly what's going on. So, it has been something that I know was very much touted and trumpeted seven or eight years ago but certainly hasn't taken off in the way that people thought it would. (I1)

While this perspective is not borne out in the literature, it shows a critical approach to pedagogical practice based on Dennis's experience of the affordances of the traditional classroom and the diverse needs of his students. In Dennis's judgment, the technological affordances of videos to shift the timing of direct instruction were trumped by his knowledge of student diversity and his perception that the presence of a teacher who can dynamically react to student needs was valuable during the initial phase of learning new content.

While Dennis rejected flipped learning from a pedagogical perspective, Louise drew on her wisdom of practice of trying to use a flipped method in Mathematics, ultimately rejecting the approach based on her knowledge of student self-discipline and home life. She explained:

Louise *Trying to get them [the students] to watch at home can be difficult for a range of reasons. You know they might not have access to good internet*

	those sorts of things will inhibit them to be able to do the flipped learning. And it really lent on them to have that independence to go off and be motivated enough to watch it before they got to class.
Researcher	*And that didn't happen?*
Louise	*No. For Some students it does. But if not all students are doing that it makes it very difficult then the following class to come in and go 'now you've all watched this video, no half of you haven't'. To then be able to try and teach it. (I1)*

This theme of students failing to watch the videos at home emerged as a common experience among the teachers in this study. Lucy set the video *The Meaning of Appropriation in Art* for Year 9 Art homework in an attempt at flipped learning, but estimated "probably half" (I1) of students completed the work. Troy experienced a similar rate of students watching his optional pre-class videos, reporting that "Maybe 50-60% of the class will go and do that" (I1). Helen asked students to complete a video-based worksheet from their Year 8 Science class at home, and found only 12 of 22 completed it (personal communication, 7/9/18).

This data mirrors the concern of Abeysekera and Dawson (2015) who argued that the central difficulty of the flipped model is that "flipped classroom approaches wager the success of in-class activities on the likelihood of students completing their pre-class assigned work" (p. 2). Interestingly, it also casts doubt over how engaging students find videos without the guidance of their teacher, as the rate of viewing was so low. These findings suggest there may be a need for further study investigating the affective impact of video compared with text-based homework, but that is beyond the scope of the current project.

The evidence in this study suggests that while teachers had knowledge of the theoretical advantages of flipped learning, considerations of student diversity (Dennis) and the difficulty of ensuring students actually watch the videos (Lucy, Troy, Louise, Margaret, Helen) meant that they rarely relied on the use of videos in this way. The knowledge of learners and their characteristics garnered from the wisdom of practice made teachers question an approach that has been shown to be successful in other contexts (Gross et al., 2015; Murray et al., 2015; Schultz et al., 2014; Smith & Suzuki, 2015). This shows that while knowledge developed through personal experience was influential in framing teacher use of instructional videos, knowledge of pedagogical scholarship was not.

6.1.5 Knowledge of Learners - summary

This section has outlined four ways in which knowledge of learners and their characteristics affected teacher selection and use of instructional videos. Student preference and attention were reported as instrumental in teachers deciding to use videos in the first place, strengthening previous findings in the literature that instructional videos can lead to greater motivation and engagement (Hsin & Cigas, 2013; McNeill & Pimentel, 2009; Murray et al., 2015). In other words, teachers identified both that students enjoyed videos, and that they were helpful in keeping learners engaged, and this knowledge was often the motivator to search for a video to use in class. The next two themes, teenage culture and prior learning, informed the particular videos teachers chose, ensuring they were neither overwhelming for students, nor 'corny'. This belief supports the proposition in the ICALM (Plass & Kaplan, 2016) that instructional videos can promote certain cognitive affective states, and also suggests a tacit understanding of cognitive overload derived from wisdom of practice. Finally, teachers tended to shun the flipped learning model widely advocated in the literature due to a perception that students failed to watch videos in a flipped learning context, or the perception that students benefit from guidance while watching videos meant. This section reveals knowledge of students, both as individuals with preferences and desires, and as learners with prior knowledge, is influential in the selection and use of instructional videos.

6.2 Curricular Knowledge

This section will reveal not only that curricular knowledge emerged as an important consideration for teachers when deciding which videos to select and how to select them, but also that curricular knowledge may be more accurately conceptualised as knowledge of three types of curricular materials, and the "indications and contraindications" (Shulman, 1986, p. 10) for their use. As outlined in more detail in Section 2.1.4, these three types of curricular materials include mandated learning goals as set by educational authorities and interpreted locally by school leadership; prescribed textbooks; and other curricular materials including, but certainly not limited to, instructional videos. Shulman (1986) describes these as the "*materia medica* of pedagogy, the pharmacopeia from which the teacher draws those tools of teaching that present or exemplify particular content and remediate or evaluate the adequacy of student accomplishment" (p. 10, emphasis in original). This chapter also proposes that in a digitally connected world curricular knowledge may also be extended to include knowledge of how to search for and choose curricular materials such as instructional videos from an exponentially expanding *materia medica*. This is particularly the case when searching on large user-generated platforms like YouTube on which only a small proportion of videos are educational.

This section starts with a discussion of how knowledge of curriculum, and a perceived hierarchy of authority amongst the three curricular sources, affected the ways in which teachers searched for and used instructional videos. It continues with a discussion of the way user-generated content platforms like YouTube may problematise Shulman's (1986) conception of curricular knowledge as knowledge "of the variety of instructional materials available" (p. 10). The section finishes with a discussion of the design characteristics teachers considered when selecting instructional videos, Shulman's *indications* and *contraindications*. These are compared to the research outlined in Chapter 3 on CTML design principles to determine the level of confluence and divergence existing between the data and the literature. Implications of convergence and divergence are discussed.

6.2.1 A Curricular hierarchy

In his description of PR&A, Shulman (1987) argues that planning to teach begins with the comprehension of a text to be taught. His definition of a text is broad, encompassing "a textbook, a syllabus, or an actual piece of material the teacher or student wishes to have understood" (Shulman, 1987, p. 14). While these three terms may appear discrete, data from this study reveals that these examples are interconnected in a curricular hierarchy, with instructional videos as a form of 'other material' generally considered by teachers as subordinate to mandated curriculum and textbooks.

The mandated syllabus is one kind of curricular text. In Victoria, the syllabus that all schools are mandated to adhere to is the Victorian Curriculum, which is "derived from the Australian Curriculum" (VCAA, 2015, Copyright Notice) and "sets out what every student should learn during their first eleven years of schooling" (VCAA, 2015, Introduction). At the time of data collection, schools in Victoria were in the process of transitioning from the Australian Curriculum to this more recently released state based Victorian Curriculum. Students opting for an academic pathway in the final two years of education in Victoria undertake the VCE and both schools in this study offered this program. Subjects in the VCE are outlined in individual subject study designs written and maintained by the Victorian Curriculum and Assessment Authority (VCAA). Because each school in this study was run under the auspices of a Catholic education system, each was also required to offer a program of Religious Education as prescribed by their respective diocese (The Archdiocese of Melbourne for Station College, and the Diocese of Sale for Wayfarer College) in addition to the Victorian Curriculum.

These mandated curriculum documents and their interpretation at a school level determined the topics to be taught. For example, it was the Victorian Curriculum that acted as a key motivator for selecting videos in Troy's practice at Wayfarer. Indeed, it was partly Troy's frustration with his inability to find videos closely aligned to the Victorian curriculum that motivated him to make his own YouTube channel:

> What we do here and what we do in this curriculum in Victoria dictates what videos I'll do… and that's the beauty of me making my own videos because I know that a hundred percent of the stuff in that educational video is related to the curriculum and examinable. (I2)

For Troy, because of the knowledge that his job involved the delivery of the Victorian Science Curriculum, this document acted as an external motivator to find videos that aligned with its prescriptions. When he struggled to find closely aligned videos, he was motivated to invest effort to create his own, given each took him "about a day" (I1) to complete. Importantly, Troy recognised not only the role of the mandated curriculum, but also its local interpretation by school leadership, in his use of the term ‘what we do here’.

At Station, the transition from the Australian Curriculum to the Victorian Curriculum acted as boundary by which Helen determined the ongoing viability of a particular ClickView video entitled *Food and Digestion: Science Building Blocks* (V24). While she considered the video and accompanying worksheet effective, she was unsure whether the specific content would remain the responsibility of Science. She explained:

> [The video] does a lot of the food tests that, I don't know, somehow in in going from Victorian curriculum to Australian Curriculum to Victorian Curriculum I don’t know where they’ve gone… do they want me to test food or don't they? Am I doing nutrition here or are they doing it in Physical Education? And yes, I think that maybe schools haven’t found enough time to look at where all the cross-links are so that I don't touch anything and then have the PE teacher go yesterday ‘we are doing nutrition!’ (I2)

Helen’s future use of this particular video resource was predicated on her developing knowledge of where ‘they’ - meaning the VCAA - demarcated Science and Physical Education, and how Station College interpreted that boundary. Both Troy and Helen, working in separate contexts, demonstrated that their knowledge of a mandated syllabus and its local interpretation acted both to motivate and bound their selection of instructional videos. This local interpretation of the syllabus is reified in the writing of school curriculum documents, but also in the selection of a prescribed textbook.

Prescribed textbooks were particularly influential at Station, where the data suggests they often mediated the selection of instructional videos. As explained in Section 6.1, teachers often saw the value of videos as a tool for engaging learners, particularly when other resources including the textbook were seen as demotivating or unpopular with students. As Helen succinctly explained, “the reason I wanted them to look at the video was because most of them won't read the textbook” (I2). However, even while acknowledging the affective limitations of text-based learning, videos were still chosen because of their alignment with the text.

Margaret acknowledged this hierarchical relationship when discussing her selection of a video by YouTube producers *The Bible Project* on the Gospel of Mark (V45) for her Year 10 Religious Education course, saying “I've got to remember as an older teacher that students need to be entertained and so forth but [the video] encapsulates everything that we've been going through in class from the textbooks” (I1). The first half of her statement indicates the role of the video, while the second half demonstrates the role of the textbook in mediating her video selection. She went on to describe the centrality of the textbook and the local curriculum in the way the video was used:

> They didn't take notes, [the video] was just to add information. And then when we went back to the text, we'd done the text - what we did was there's a little bit on each of the gospels in the textbook… this is to enhance what is in the book. So, I’m not all that concerned if they didn’t pick up every single bit because they are not going to be tested on every single bit.

The lesson had started with the textbook, used the video to engage the students and “add information” then returned to the textbook. The material for an upcoming test had been derived from the textbook, and so again the status of the video is indicated by Margaret’s words that she wasn’t concerned if they didn’t “pick up every single bit.”

The prerogative to select videos that supported the text book was also mentioned by Carl, who explained his preference for YouTube's up-to-date content because he regularly found videos focusing on "American companies which is in line with our textbook" (I1). He was less enthusiastic about the subscription-based video service *EdRolo* that Station had paid for, because "it's not completely in line with the textbook, so it can get a bit confusing for some kids" (I1). The comparison between these statements reveals the clear impact knowledge of the textbook had on selection of instructional videos.

While the textbook remained authoritative in definitions and examples it contained, videos were used when the curriculum mandated content that the textbook did not contain or did not treat in adequate detail. Dennis explained that when teaching the history of the UN partition of Palestine, "we'll actually show the video that goes through a bit more of the history for them because the textbook is, it's relatively scant" (I2). Additionally, Carl saw the value of YouTube's constantly updated range of videos to deliver up-to-date case studies in Business Studies when the textbook became dated, explaining "the textbook's got some really old stuff that wasn't really relevant, I wanted to pull something that was a bit more relevant" (I2).

Shulman (1987) described three types of texts used by teachers, but did not explore the relationships between these categories. For the teachers in this study, a loose hierarchy of curricular sources emerged. Knowledge of this hierarchy motivated, bounded, and mediated the selection of instructional videos. This suggests that curricular knowledge may go beyond Shulman's (1986) lofty definition of:

> The full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of materials available in relation to these programs, and

> the set of characteristics that serve as both indications and contraindications for the use of particular curriculum. (p. 10)

Teachers indicated that they also draw on knowledge of the relative authority of curricular sources when engaging in the process of choosing videos from third party providers. Unlike knowledge derived from the wisdom of practice, knowledge of mandated curriculum and local interpretations acted upon teachers, bounding their freedom and determining what they would teach. This calls into question Shulman's (1986) assertion that knowledge "guarantees only freedom, only the flexibility to judge" (p. 13), suggesting instead that knowledge of mandated curriculum acts as a boundary to freedom, only within which teachers may act independently.

Shulman (1986) argued that, as part of curricular knowledge, teachers should possess knowledge of "the full range of programs designed for the teaching of particular subjects" including "the alternative texts, software, programs, visual materials, single concept films" (p. 10) concerning the topics to be taught. While this was no doubt a demanding knowledge base in 1986 when Shulman was authoring his work, teachers now face what has been described as "a resource bounty… a bewildering avalanche" (Andrist et al., 2014) the increasing use of open platforms like YouTube, which hosts an exponentially increasing catalogue of over four billion videos (Bärtl, 2018) has made knowing all of the available resources an impossibility, and selection from amongst this catalogue a demanding task. The next three sections outline the types of knowledge teachers drew on when undertaking this demanding task; namely prior knowledge of video sources; knowledge of effective search strategies; and knowledge of effective video design.

6.2.2 Knowledge of existing videos

While all of the teachers were able to recall videos they had used recently, surprisingly few of were able to list any number of specific videos that they had used on multiple occasions, and had found reliable or pedagogically useful for their students in the past. Of the participants, only Helen and Dennis were able to recall such a list of videos in conjunction with the particular topic taught, the associated learning activities, the misconceptions of students, the pros and cons of the design, and their relative effectiveness. For these two experienced teachers, this knowledge of existing curricular materials drew on multiple teaching iterations and showed evidence of fine tuning.

In one such example, Helen described a very old science video she had used on many occasions to help teach the reactions of volatile substances with water:

> Last week I used parts of a very old movie called "The Elements Organised" because I was trying to get the kids to understand the patterns on the periodic table and really work with gases and things… I can show the whole 25 minutes from YouTube because it was a 16 mil movie - you can see whoever's put it up has taped it from the movie - or I can show just the 10 minutes that I like because it's Lithium, Sodium, Potassium. And some of that's about the time issue, so I've got both links [in my PowerPoint] with a little descriptor so I know which one is which… You sit and assess it as suitable content or not suitable content depending on the age group of the kids. So I will show Year 10s [Brainiacs] blowing up a bathtub and I'll show the year 8s that section out of the elements organized because they go they go as far as caesium, but they've got the big glass wall glass thing that shatters so they don't do the ones after. (I1)

Helen had used the video often enough that she had noted exactly the parts that were most pertinent to teaching the topics in the curriculum. She understood that because of the demands of time she needed to segment the appropriate section of the film. Furthermore, because of the potential risk involved with the subject matter, she knew that this video was most appropriate for younger students, while the Sky One series *Brainiacs* was acceptable for older students learning similar topics. In describing not only the relative appropriateness of the two videos for various audiences, but also the ways in which they could be manipulated, Helen demonstrated the kind of knowledge Shulman (1986) seemingly envisioned when he likened curricular knowledge to the knowledge of a physician:

> We expect the mature physician to understand the full range of treatments available to ameliorate a given disorder, as well as the range of alternatives for particular circumstances of sensitivity, cost, interaction with other interventions, convenience, safety, or comfort. Similarly, we ought to expect that the mature teacher possesses such understandings about the curricular alternatives for instruction. (p. 10)

Dennis demonstrated a similar breadth of curricular knowledge. He had an extensive knowledge of many documentaries he had used for various topics in his 20th century history subject, and waxed lyrical about their respective pedagogical value. To the first question in our first interview about any videos he had used recently, Dennis enthusiastically launched into describing his favourites:

> There was a series from late 20th century late 1990s narrated by Kenneth Branagh called the Cold War which focuses on different conflicts or different eras within the Cold War. So that's used to get across the different concepts about communism and get across different periods in time. The most recent one the students watched is

called Reds, so that got across the way that the American political system works. This is how Senator Joe McCarthy was able to have so much power versus President Eisenhower, who you think should have been the one able to just shut anything down but he actually felt that he couldn't do that, what was that like? As part of that we can look at bits of the American Constitution and say ‘okay how do you actually get around those bits, and how does that then translate into the paranoia that exists and relate them to the events like what's going on in Europe at the time, so Soviet control of Eastern Europe, Berlin Blockade, Korean War, all those things?’ (I1)

Dennis was excited to share not only the videos, but the key conceptual change he wished to see in his students from each, and his sentences about one concept often didn’t finish before he began talking about another. For Dennis, his memory of the films was inextricably linked with their potential to teach salient content. Later in the same interview, he reflected on another series of videos he had used:

> Crash Course. They're great. They engage students and they're all 11-12 minutes. So they're generally really good for just introducing or reinforcing a topic. And it really depends on which end it is because he moves so fast in them that in some of them you've got to already know what he's talking about to actually get something out of it. And I've discovered that the hard way because the first time I discovered them I thought ‘ah awesome great I'll use these’. I showed one of them in class and then realised the kids just went "Yeah that was entertaining but what?" (I1)

Importantly, Dennis’s answers did not just reference the videos, but other materials like “the American Constitution,” and potential student misconceptions like the power relationship between McCarthy and Eisenhower. His *Crash Course* example included reflections on elements of the video that had confused students, and therefore its future usefulness, in that students already needed to know something about the topic to appreciate them. These particular videos had been transformed in his mind into examples of “practical pedagogical wisdom” inseparable from the “story-based” (Hashweh, 2013, p. 120) memory of their benefit in the classroom. It is this knowledge of the relative strengths of each video demonstrated by Helen and Dennis that seems close to the kind of knowledge envisioned when Shulman (1986) described “understandings about the curricular alternatives available for instruction” (p. 10). More commonly in this study, teachers reported using a video for the first time and so did not act with the benefit of such wisdom of practice, meaning searching for those videos was centrally important. Selection of new videos involved a range of search practices that are examined in the next section.

6.2.3 Search strategies

This section outlines the search practices engaged in by the participants, including their use of online platforms, and the various lengths to which each went to preview and fact check those videos before selection. Given the rapidly expanding catalogue of curricular materials available to teachers on platforms like YouTube and ClickView, the ability to search for and select from amongst a range of materials could arguably be termed a new type of curricular knowledge. This is an extension to previous models of curriculum knowledge. However, the teachers in this study rarely displayed evidence of a refined search repertoire, more regularly using a practice that could be termed *search and* scroll. Teachers described the practice like this:

> I just do my usual jump into YouTube, put it in the key words ‘public relations campaign’ or ‘public relations PR stunts’ another key word to sift through the videos on YouTube. (Carl, I1)
>
> Generally, I start with a search engine and generally that happens to be Google because we use Google apps for education here anyway so I'll type in trigonometry and I'll have a look at the YouTube clips that are available. (Helen, I1)
>
> Generally, I just YouTube it, click and see if there’s something that’s appropriate… I put in canonisation and that was the first one to come up. (Alison, I1)
>
> So sometimes it takes a lot of digging through YouTube to find the right ones that are not only easy to understand but also correct in terms of the content. (Troy, I1)
>
> I would go to YouTube probably first… I would just start by searching ‘lesson on watercolour’ (Lucy, I1)
>
> I just looked up YouTube and looked up William Blake and William Blake lectures that sort of thing. And then I just sort of go down, take a look. (Margaret, I1)
>
> I knew I wanted to teach diffusion so I use the keywords to search for that (Louise, I2)

The descriptions of the search and scroll technique suggest something unremarkable and ordinary, with four using the word ‘just,’ suggesting that the YouTube search function had become what Bruce and Hogan (1998) termed transparent technology, a term later adopted by Mishra and Koehler (2006) and developed by Cox (2008). The search and scroll method represented a new form of labour which while considered banal, felt demanding in terms of the time it took to complete. Alison went as far as saying that when she knew the content well “it is sometimes easier just to say it myself” (I1) rather than trawl through YouTube. It is interesting to note, however, that when she felt her content knowledge was too low to 'say it myself' she found videos to support her teaching (see Section 6.4).

Because of a perception of time poverty, less than half of the teachers (Dennis, Lucy, Louise, and Melissa) stated that they watched all videos they selected entirely during the search process, before showing them to the class. Louise saw pre-watching as an essential practice as it allowed her to contextualise the content, saying "I always make sure I watched the whole thing first before so I know what's coming so I can chat to the class about it" (I1). Similarly, Melissa saw the value of pre-watching in terms of creating meaningful learning activities, saying "so maybe if you were another teacher who didn't know as much about the video or hadn't watched it maybe the class would just watch it and then it would become less purposeful" (I2). Margaret saw that an important advantage of pre-watching a video was that she could monitor the students' interest and responses, because as she explained, "I've seen it, so I'm watching them" (I2). Dennis was adamant that the video sources he used needed to be both fact-checked and analysed for historical bias. When questioned on how he went about doing so, Dennis went to his bookshelf to show me the historical volumes he had bought to read over the holidays in order to develop his CK and improve his ability to discern good sources. For these teachers, previewing and fact checking videos were prioritised in their practice and this drew on a range of other knowledge types.

In contrast, Carl and Troy reported choosing videos in a rush, just before class, admitting they often showed YouTube videos they had not fully watched. In this circumstance, fact checking, or activity planning was difficult. Carl admitted that when scrolling through YouTube search returns he quickly checked for form, but not substance, suggesting "I suppose if I had the time I would have to fact check it but just at the moment I just don't have the time" (I1). This shows a clear process of selection, or triaging of tasks (Philipp & Kunter, 2013), and suggests that while he recognised that optimally a teacher would check the reliability of content, he chose not to in order to manage the demands of teacher labour. The practical upshot of this approach was that during a class observed for this study, Carl showed a video on guerrilla marketing to his VCE business studies class that left him confused. He said, “I'm just assuming it was a not-for-profit trying to promote something” (I2) when in fact the video was a promotional stunt for a new online marketing company.

Similarly, during a class observed for this study, Troy showed a 14-minute instructional video on energy sources (V57) of which he had watched “a few minutes” and thought it “looked good” (O). He explained that he “rarely” (I2) watched videos all the way through, and explained the process by which he selected them as:

> I tend to just watch snippets, like I'll audit the video. I guess I'll see the start of it maybe every quarter or 5th I'll skip ahead and see what kind of terminology they use, see if it's consistent with what we use in the class... So I don't really have time to sit and watch the whole thing so I'll just watch little snippets. (I2)

This practice of choosing learning materials using the search and scroll method was less about having a defined “curricular repertoire” (Shulman, 1987, p. 16), and more being able to efficiently find materials on online platforms.

Other participants reported a range of deliberate strategies to refine this search labour that could arguably be called curricular search knowledge. Melissa reported searching for videos as a result of her academic reading. For example, she reported finding an article by a university professor on the stages of genocide, then searching for his name and selecting a short explainer video by him (V51) as a way of ensuring the content was reliable in a field in which her CK was low. She acknowledged the fraught nature of using a simple search and scroll method on YouTube because:

> there's a lot of students whether they be university or high school that create things and put them on the internet and a lot of them are on YouTube so then you've got to figure out if you've got a reliable source. (I1)

In this instance, Melissa found a way of compensating (Philipp & Kunter, 2013) for her low CK which she reasoned was not good enough to fact check the range of resources online.

Alternatively, some teachers came to trust certain producers, assuming their content would be factually sound. When explaining why she didn't actively fact-check the video she used in her Science class, Louise expressed that "everything I've watched on Crash Course has been pretty reliable, so I just trusted" (I2). Similarly, Troy was happy to trust the Bill Nye series (Section 6.1.2) because he believed they were "created in association with some American science organisation" (I2). This trust of producers became a short-cut to deal with the lengthy process of searching for resources.

An interesting effect of the reliance on a search and scroll search technique is that teachers who used it were often unaware of videos that existed on their favourite providers' YouTube channels, despite expressing that such videos would be useful. For example, Alison said that "while at university" she had been exposed to the Crash Course videos as part of her History method studies, and she called them "brilliant" and "fantastic" (I1). She bemoaned the lack of such videos in her other teaching areas, saying "it would be great if there was that for English" (I1), unaware that Crash Course has produced a series entitled Crash Course Literature. Troy cited US educator Mike Sammartano as one of his preferred producers, and used a video titled *Continental Drift* (V54) to teach about tectonic plates. Troy was unaware that Sammartano had on his channel a video specifically titled *Plate Tectonics* on his channel. He explained that “I haven't actually gone into his channel it's just whenever I search for a topic and try and look for videos if I see he has one I just use that, but I should go into his channel” (I2). This reliance on the search function trusts the algorithm to surface appropriate content, the problematic nature of which is discussed in Section 7.3.4. An outlier to this practice was Louise who reported starting her searches within her subscribed channels, explaining that “otherwise you get so much stuff. I try to do that first and then go broad if I can't find something within there” (I1).

Regardless of the methods used to streamline the process, the actual labour required to search for a video emerged as more onerous than may be initially apparent from the simple way teachers described the search and scroll method. This plays into a wider narrative about the role of teacher labour in increasingly technology-rich educational contexts (Selwyn, 2019). Interestingly, given none of the teachers reported using any of YouTube’s advanced search functions and only Louise reported searching within her subscriptions, differences in self-reported TK among the participants had no impact on search practices.

The prevalence of ‘search and scroll’ will become more important in the next chapter when the role of the YouTube algorithm is discussed, as not only are search results mediated by an active algorithm, but producers of educational content are required to make videos that rise to the top of these searches to avoid obscurity (Bishop, 2018). The more strategic approaches to searching, such as Melissa’s search for scholars on YouTube, or Louise’s search from within a producer’s channel suggest that discovering new teaching materials relies on a particular type of curricular knowledge, namely platform search skills. Equally however, this data reveals that most of the teachers had automated a rather uncritical process, termed here search and scroll.

Teachers require an ability to quickly search and sift through a vast and ever-changing corpus of teaching materials based on their knowledge of content, learners, and pedagogy. The specific factors that teachers look for in videos and the knowledge they draw on while engaging in this search process are outlined throughout the rest of this chapter. In particular, the design factors preferenced by teachers and their alignment with.

6.2.4 Knowledge of video design - a tacit understanding of CLT/CTML?

Shulman (1986) suggested that curricular knowledge included knowing the "indications and contraindications" (p. 10) for the use of certain curricular materials. While he did not develop this concept in depth, it could reasonably be understood to include considerations of instructional design when selecting learning materials. When searching for videos, teachers consistently reported paying close attention to certain design features they considered made videos more, or less, instructionally effective.

Interestingly, in response to the direct question '*are you aware of any research about educational video design'* the nine participants all replied in the negative. Eight of the participants replied immediately and quite directly, saying "no research, no" (Margaret, I1), "nup" (Helen, I1), "nup, it didn't come up" (Alison, I1), "no, that wasn't part of [my study]" (Louise, I1), "no, nothing" (Melissa, I1), "no" (Lucy, I1; Carl, I1), and "not at all, no" (Troy). This was despite three of the participants (Carl, Alison, and Melissa) having finished their teacher education in the three years prior to data collection, one having recently completed her Master's degree in educational technology (Louise), and one creating educational videos for commercial gain (Troy). Given the recency of their studies and the interest in educational technology, these five teachers might be considered "extreme cases" (Flyvbjerg, 2006, p. 13), in that they are teachers most likely to have been exposed to the growing base of research outlined in Chapter 3. Flyvbjerg suggests that studying cases that are ‘most likely’ allows an important step towards generalisation. Because they are the most likely to have had exposure, the lack of formal scholarship about effective instructional video design may not be unique to these teachers. Given the rising use of videos in education, this is an interesting finding for those involved in designing initial teacher training courses.

Despite this lack of awareness of research in the field of effective video design such as that outlined in Section 3.5, there was consistent convergence between their wisdom of practice and the findings of experimental research. By presenting the considerations of teachers under the titles of the CTML principles, this section makes the claim that at least with regard to effective video design, teacher wisdom of practice generally supports the findings of lab-based experiments, and vice versa. While each principle is briefly outlined here, readers are encouraged to refer to Section 3.5 for more thorough descriptions.

6.2.4.1 Coherence

Coherence describes the degree to which instructional material such as videos include only information essential to the learning goal, eliminating anything extraneous or distracting (Mayer, 1999; Mayer & Fiorella, 2014). When selecting videos, all of the teachers in this study demonstrated tacit consideration of the coherency principle by preferencing materials that included only content relevant to their specific teaching aims and also by preferencing videos that delivered content in an engaging manner without distracting students from the learning aim with unnecessary extraneous design features. These are addressed in turn below.

A theme amongst the teachers was the desire to find videos that addressed their learning goal, but that did not present too much extraneous material, which was at times a challenging task. Two examples are presented to demonstrate the impact of topic coherence on the selection and use of instructional videos. Dennis reported that finding videos whose content was limited to his learning goal was difficult when searching for videos on the Arab-Israeli conflict for his senior History class, because he wanted:

> Something that's going to go back to Zionism but I don't want it to really go beyond 1948… Whereas when you use a video that goes further into the Suez Crisis of 56, the creation of the PLO in 64, the Six Day War, and you start to see a lot more aggression from the Arab States and Arab entities, they tend to look very differently at the starting point. So I got something that actually ends right there [in 1948]. And even last week when I was going back over this video I'm going 'okay some of the sound quality on this is dated and the visuals aren't great'. Like you noticed that even when I paused it to get them to write the percentages down. It's like 'okay visually that's not great, graphics are so much better now' but when you go on to other videos they just can't help inserting biases from now... Whereas, because this is much more self-contained, up to [1948], it suits the purpose of 'okay this is the spark,' the start of looking at this unit rather than an overview.

The desire for a tightly focused and coherent video was such a priority that Dennis rejected several other options with higher production values, evidence that while Dennis saw production quality as a factor, he considered coherency as more important. In order to counter the effect of the poor production quality, Dennis regularly paused the video to allow students to copy down information that was otherwise quite hard to read. In Dennis's reasoning coherence was a primary, rather than secondary consideration.

Like Dennis, Science and Mathematics teacher Louise was concerned that content extraneous to her specific learning goal would overwhelm her students. And while she followed a similar pattern of preparation, her weighting of considerations was different to Dennis's as she ultimately preferenced production quality and affect over coherence. She described her reasoning for selecting a Crash Course video on the nervous system for her Year 9 Science class:

> I did do a broad YouTube search for the nervous system and a couple of things came up but again I always get drawn to Crash Course because I like the colourfulness and the logical nature of the way he [host Hank Green] goes through things as well. So I always make sure I watch the whole thing first before so I know what's coming so I can chat to the class about it… and from a content point of view I need to make sure it's covering all of the important stuff. So while it did go a bit further than what I needed in it, it was still a really nice overview of [the nervous system] to go through it with them. (I2)

Like Dennis, Louise had watched the video through and identified a problem with it, namely that 'it did go a bit further than what I needed,' but unlike Dennis she had considered this not to be reason enough to reject the video. More important in her broad search were the production value and 'logical nature' of the Crash Course video, showing the secondary importance of coherence in her reasoning. It is possible that these decisions differ because of the audience (junior vs senior students) or the complexity of the subject matter. Regardless, this shows that two experienced teachers may reach alternative outcomes due to the relative weighting of considerations. As Shulman (1986) argues, "reflective awareness of how and why one performs complicates rather than simplifies action and renders it less predictable… knowledge guarantees only grounded unpredictability" (p. 13).

In order to counter the overwhelming effect of the extraneous material, Louise introduced the video by reassuring her students that "it goes through all types of nerve cells, but you don't need to know them all, so don't freak out" (O). She followed the video with an activity that required students to cut and paste the basic structure of the nervous system, focusing only on her specific learning goal, the high-level structure of the nervous system suggesting coherence was still a consideration for Louise.

Both Dennis and Louise engaged in live practices to counter the perceived deficiencies of the videos they chose. This highlights that selection of videos was rarely a search for the 'perfect' video, but rather one that would be useful with teacher input. This shows a difference between experimental designs and actual teaching contexts, as videos in experimental settings are typically purpose made or tightly focussed on the particular learning goal. In such a circumstance, knowledge of the superiority of learner control under experimental conditions (Hasler et al., 2007; Schroeder et al., 2019) may be of limited value.

With regard to coherent visual design, the views expressed broadly aligned with Mayer (2014c) that multimedia should include enough to motivate generative processing without overloading learning through extraneous processing. Three brief examples are offered to highlight this consistent sentiment. After suggesting videos needed to be engaging, Margaret added the caveat "let's not go too overboard either, because that can be distracting you know, if it's such that they might be looking at all that and maybe not taking it in" (I2). Margaret identified the cognitive danger of seductive details, in that such poor designs can cause students to 'look at all that' and impede student learning, or what Margaret termed 'taking it in'. While not using the language of encoding, schemas, and cognitive overload, Margaret had neatly summarised the main findings of the experimental literature described in Chapter 3 (Mayer & Fiorella, 2014; Ozdemir & Doolittle, 2015).

First year teacher Alison echoed this sentiment when describing why she chose a video on canonisation by *Busted Halo*, suggesting “there's not too much going on, I don't know how to explain it but the text choice and that kind of thing, it's very bright and bold and colourful but not too over the top” (I2). While Alison struggled to explain her reasoning as clearly as Margaret, she accurately summarised the findings on coherence and the seductive detail effect, suggesting that while videos should be attractive, this attractive design should not distract from the key content by containing “too much”. Troy also expressed a similar view as to his preference for coherent videos, saying “I just look for videos that have very clear simple animations and just really clear narration as well” (I1). Alison, Margaret and Troy, while at varying stages in their careers and teaching different subjects, had come to the same conclusion which also converged with the findings from experimental literature. This both lends context situated support to the experimental literature (Park et al., 2011; Towler et al., 2008), while suggesting that teachers were unaware of the theoretical basis for their intuitive understanding.

6.2.4.2 Video length and Segmentation

There is overwhelming consensus in both experimental and case study research that shorter instructional videos result in better learning outcomes than longer ones when the shorter ones still present the key learning material (Brame, 2016; Cooper & Higgins, 2015; Guo et al., 2014; Hansch et al., 2015; Harrison, 2015; Langworthy, 2017; Savage, 2009). When asked for an ideal length for instructional videos, the most cited figure amongst the participants was 5 to 10 minutes (Margaret, Alison, Melissa, Louise, and Troy). Helen suggested 15 minutes as an ideal length, and Carl said "I usually keep my videos under 4 minutes" (I1). There was a clear consensus that shorter videos were preferable to longer ones.

In addition to these preferred ideal video durations, teachers also drew on their understanding of the dynamics within particular classes when determining the maximum length of the videos they actually selected. Carl explained that "it depends on the class, with that Economics class, definitely under five minutes" (I2). He went on to explain that in this particular Economics class there were students that he believed had short attention spans and that experience had taught him to keep activities brief. Helen, too, determined that a longer video on digestion that had worked well in her all girls Science class was less likely to work with her all boys class, in which "8 out of 24 [students are] on individual learning programs, which unfortunately makes it so any activity needs to be short and sharp" (personal communication, 11/9/19). These responses highlight Shulman's (1987) argument that choices about curriculum are not made in isolation, but for particular groups of learners. It is this knowledge of the micro-context (see Section 7.1) that is rarely considered in experimental designs, and even less so in analyses of massive data sets such as those done by Guo et al. (2014).

While the teachers generally advocated the principle that shorter videos were preferable over longer ones, this was not a rigid rule, and other forms of knowledge were engaged in considerations of video length. This supports both Shulman's (1992) argument that teacher reasoning is "messy" (p. 7) and the view of Lowe and Schnotz (2014) who argue that it is impossible to develop fixed rules that can be "mechanically applied to guarantee a satisfactory educational outcome" (p. 536). Dennis went as far as to argue that video length was secondary, and that more important was how long the video could capture the attention of the students.

> I've shown 10-minute videos… if after 2 minutes it's not engaging, it doesn't matter that you're only asking them to hang on for 10 minutes. You'll lose them. So it's got to have enough in there that will interest them, and as a historian having that source footage as well as some expert opinion, as well as interviews with some primary sources as well. (I2)

Troy had come to a similar understanding through experience. He initially offered "five to ten minutes" (I1) as the ideal length for junior students, but after finding the 25-minute Bill Nye videos he refined his idea of duration, explaining that "it's not length, but that said it could be length in terms of how long the video spends on one particular scene or one particular topic" (I2).

The idea that the production quality or engagement of a video extended the usable length was supported by teachers who over or under-estimated a video's length depending on their perception of its quality. Helen said that Khan Academy videos were "generally very long-winded and some of [the students] just lose patience" (I1) even though almost all of their videos fall under her ideal 15-minute threshold. Carl declared that he tried to "keep my videos under four minutes" (I1) and was surprised to hear that the average video length for his favourite politics channel *Real Politik* was approximately 12 minutes.

When selecting videos for students, the teachers in this study considered not only the length, but also the knowledge of learners, the likely affective impact of the video, and the relative utility of the video with regards to the curriculum were also taken into consideration. While teachers broadly aligned with the video length reduction principle (Section 3.5.4.4), this highlights Mishra and Koehler's (2006) argument that parsing teacher knowledge is an analytic act, because in practice knowledge types are interlaced and hard to separate.

6.2.4.3 Segmenting

Segmenting describes the practice of breaking longer videos into shorter segments (see Section 3.5.4.5). Suggesting a tacit understanding of the segmenting principle, Melissa posited that longer videos could be used effectively when broken into segments. This was, she said, particularly important when the information was complex and potentially overwhelming:

> In History some things can be so dense. If you're talking about fascism, communism or things like that when there's so much information… So, if I do have a big clip I usually break it into sections or I'll figure out the part that talks about the stages I want to talk about and just show that. And then come back to the other parts later, or not. (I1)

Her description suggested an understanding that apparent student boredom may be because of cognitive overload, ‘so much information’ rather than disinterest. Melissa drew on her knowledge of her particular learners and their prior knowledge, along with a tacit understanding that too much information overwhelms learners. This belief about cognition the limited capacity assumption in CTML (Mayer, 2014b; Wiley et al., 2014).

Margaret cited similar cognitive factors for segmentation, suggesting that longer videos need to be broken up in order to “let them catch up with the notes or have some question time or check if they've actually taken it in” (I2). This term “taken it in” implies an internal process of encoding or sense making that students need space to achieve. This too is supported by the findings of CTML, particularly when paired with active learning tasks as Margaret describes (Cheon et al., 2014). Practices like these show that teachers can segment longer videos into sections that more closely conform to the 6-10 minute maximum research consensus (Brame, 2016; Guo et al., 2014; Harrison, 2015; Kim et al., 2014; Pi & Hong, 2016).

While Melissa and Margaret reported segmenting or selecting sections of the video prior to the lesson, segmenting was also observed happening live, during the act of instruction (by Dennis and Troy), in that both teachers paused videos “on the fly”. This is evidence of the reality of Shulman’s (1987) argument that pedagogical reasoning is not linear. Furthermore, by segmenting a video during instruction, teachers were able to pause the video in response to stimuli from the class, such as a question, or discussion amongst students, showing evidence of reflection-in-action (Schon, 1987). This is discussed in more detail in Section 6.5. Practices of segmenting or selecting sections from longer videos means that calculating an average length for the videos teachers reported using would be misleading, and is one of the reasons an analysis of the videos used by teachers, which was initially part of the design of this study, was deemed inappropriate.

Teacher responses regarding the optimal length of videos, and their practices in terms of segmenting them to avoid cognitive overload or selecting sections to avoid extraneous material largely mirror the experimental findings of CLT and CTML literature (see Section 3.5). Given the responses of teachers were based on reflection-on-action in real contexts, this represents an interesting confluence of phronesis and episteme, lending credence to both. As well as lending support to the findings in the literature, the data in this study suggests a new path of inquiry regarding the consideration of affect in determining the ideal length of videos. While Guo et al. (2014) have investigated the effect of production style (talking head, lecture capture, Khan style, narrated slides) on retention, and ten Hove and van der Meij (2015) have described the characteristics of educational videos on YouTube that popular, there is a lack of research on the interactions between affective states, viewer attention, learner characteristics, and learning in video design. It is the intersection of these factors that teachers reported considering when selecting videos to use in classes.

6.2.4.4 Signalling

Signalling, also sometimes referred to as attention guiding or cueing (L. Lin et al., 2016; Xie et al., 2017) describes the effective instructional practice of guiding a learner's attention towards the details of a presentation most essential to learning. In experimental research, this is usually achieved by altering the presentation itself, for instance by adding an arrow that points to a particular detail (L. Lin et al., 2016) or by sequentially revealing details as a narrator discusses them (Jamet et al., 2008). Margaret thought that the information in the white board style *Bible Project* video was comprehensible because the "drawings appeared" (I2) as the narrator spoke, the form of signalling described in Jamet et al. (2008). Similarly, Melissa described the use of arrows to highlight important information as a positive design feature that she looked for when selecting videos, echoing the findings of Lin et al. (2016). However, because the teachers in this study mostly curated existing content, which was not designed precisely for their teaching aims, they more commonly reported engaging in practices that could be called live signalling, by which they pointed out important aspects during playback by pausing the video and drawing student attention to key material either physically or verbally. Alison described this practice as "stopping a video at different points or moving forward to different points, telling the kids these are the things I want you to pay attention to" (I2).

Interestingly, however, during the classroom observations only Dennis engaged in signalling practices. Prior to showing the video about the Arab-Israeli war (V19), Dennis informed students what they were to look for, telling them "I'll try to pause it whenever the map comes up, and watch out for bias" (O). The map was a central representational device of the lesson which was used to explore diplomatic compromise, and the students had just completed an activity during which they tried to "partition" Palestine (see Section 6.5 for a fuller discussion of this lesson). While there were many details in the video, Dennis paused the video six times, three of which were so students could record details from this map that changed as the events of the conflict progressed. During these three pauses, Dennis highlighted key aspects of the visual presentation and read some on screen text that was hard to read due to poor video quality. The remaining three pauses were to address student questions that arose naturally. Troy paused the video (V57) but to add information rather than point it out, while Helen responded to the questions of individual students watching (V24) on their own screens. More commonly, teachers played videos without interruption (Louise, Lucy, Margaret, and Carl), suggesting that an important affordance cited by teachers for showing videos on a communal screen was underutilised in practice.

6.2.4.5 Personalisation

The personalisation principle suggests that videos featuring informal and enthusiastic narration delivered using first and second person speech activates a social response, triggering greater germane processing (Clark & Mayer, 2016; Mayer et al., 2004; Rey & Steib, 2013). The responses of all of the teachers in this study echoed these findings, with a particular aversion to what three participants labelled "boring" (Alison, I2; Lucy, I2; Melissa, I2) narrators. Indeed, for Dennis, Alison, Louise, and Melissa the primary attraction of YouTube producers *Crash Course* was the personal enthusiasm and engaging nature of the presenter. For Louise and Alison, this was enough to overlook problems of coherence (see Section 6.2.5.1). Further examples of this concern for a personable, but not corny, presenter are provided in Section 6.1.2.

6.2.5 Curricular knowledge - summary

The first research sub question (Section 1.3) asks about the role of teacher knowledge in the selection and use of instructional videos. This section shows that knowledge of the formal curriculum was used by teachers to inform or bound the topics taught, and therefore the content of videos that teachers search for. Curricular knowledge was also used to guide the selection of particular videos they used, either by past knowledge of effective videos, or through search techniques and ideas about what makes an effective video. Importantly, this section argues that curricular knowledge describes knowledge of mandated courses; prescribed textbooks; and of other available resources to teach those courses. This extends Shulman's model, proposing that curricular knowledge includes knowledge of search techniques, particularly when dealing with large user-generated platforms. The impact of each of these sub types of curricular knowledge is outlined here.

First, curricular knowledge refers to a teacher's understanding of the mandated courses and content to be taught, as determined by government and local authorities. For the teachers in this study, that entailed knowledge of the Victorian Curriculum, and for teachers of VCE subjects, the corresponding study design. These documents were interpreted at a local level to determine the specific topics to be taught and the ways in which these courses would be assessed. This knowledge served as a primary source of lesson goals, and therefore mediated the subject matter of the videos that could be used.

Less consistent among the participants was a knowledge base of existing videos. For Dennis and Helen, a majority of the videos they reported using were ones they had used previously. These were recalled along with the relative pedagogical strengths and uses of each. The videos had become part of broader PCK inseparable from the “story-based” (Hashweh, 2013, p. 120) memory of their benefit in the classroom. This knowledge brought the advantage of knowing which sections to show, and the knowledge of effective learning activities to use in conjunction with the videos.

More commonly, however, teachers searched for new videos each time. This involved the adoption of strategies that mostly took the form of search and scroll on the YouTube platform. The teachers reported this process with such ordinariness that to describe it as a practice borne out of knowledge may be overstating the conscious nature of it. Having entered a search string, the teachers described the features they looked for in the videos returned by YouTube’s search function. These features, while largely consistent with the extraneous processing principles of CTML, were borne out of the wisdom of practice or an intuitive sense of student information processing capabilities. Again, this shows the messiness and interconnectedness of teacher knowledge, in that ideas about information processing capabilities could certainly be categorised as knowledge of learner capabilities, yet are here categorised as a type of curricular knowledge. As was stated in the introduction to this chapter, such arbitrary categorisation of teacher knowledge highlights the truth of Mishra and Koehler’s (2006) statement that “viewing any of these components in isolation from the others does a real disservice to good teaching” because of the “dynamic transactional relationship” between forms of teacher knowledge (p. 1030).

6.3 Content Knowledge and videos, a complex relationship

Shulman (1986) decried the lack of focus on content knowledge (CK) in discussions of education and encouraged theorists and policy makers to consider CK at the heart of teaching. Drawing on the work of Schwab (1978), Shulman argued that teachers need both a substantive and syntactic understanding of the subject matter that they teach. By this, he set the rather high standard that:

> We expect that the subject matter content understanding of the teacher be at least equal to that of his or her lay colleague, the mere subject matter major. The teacher need not only understand that something is so; the teacher must further understand why it is so, on what grounds its warrant can be asserted, and under what circumstances our belief in its justification can be weakened and even denied. Moreover, we expect the teacher to understand why a given topic is particularly central to a discipline whereas another may be somewhat peripheral. (Shulman, 1986, p. 9)

The data in this study reveals that while some of the teachers did seem to satisfy this lofty standard, others fell short in one or more topics, often by their own admission. In this section, addressing the first sub-question, the focus is what difference CK makes to a teacher's selection and use of instructional videos.

In order to reveal the impact of CK, this section takes the form of a series of contrasting vignettes, profiling two teachers and the difference developed or less developed CK had on their practices. Following Flyvbjerg (2006), these cases, rather than being typical, are deliberately chosen as "atypical or extreme" (p. 13). For example, Margaret drew on 40 years of accumulated formal and personal content study to critically evaluate her selection of videos for Religious

Education, while Alison used “the first one that came up” (I1) on YouTube because she lacked knowledge of the topic. Helen was able to answer tangential questions about the science topic she was teaching, while Troy was unable to go beyond the boundaries of the video he was showing. Finally, Carl used YouTube as a source of information, while Dennis was very critical of the platform, drawing his CK from other sources. These cases, by revealing extremes of practice, are “well-suited for getting a point across in an especially dramatic way” (Flyvbjerg, 2006) and are not meant to establish representativeness. These comparisons ultimately support Shulman’s contention that strong CK leads to more effective teaching, as it emerged as an important differentiating factor in the way teachers operated, with higher CK arguably leading to more reliable selection of videos and effective teaching practices.

It should be noted that using the definition offered by Weldon (2015), none of the teachers in this study were teaching out-of-field (see Section 2.2). However, it was clear that even these in-field teachers were at times required by the curriculum to teach topics that were outside their CK expertise. This was particularly true of teachers in broad subject domains like junior Science, and the younger teachers of Religious Education.

6.3.1 Margaret and Alison, CK in selecting for understanding

This section examines the self-reported CK and orientation of two Religious Education teachers, Margaret and Alison, and the impact this had on the way in which each selected instructional videos. When asked about her content knowledge regarding Religious Education on a scale of 1 to 10 with 10 being an expert, 40-year veteran Margaret answered “as far as Catholic Church teaching I’d like to think I was up near the 10.” In terms of the sources of her knowledge, Margaret replied:

I've been to Catholic schools all my life. I'm sort of from a generation where it was, it's very much part of who you are… and I am a practising Catholic and so forth... I started teaching RE from the word go and I was able to get my accreditation through the hours put in and so I've got accreditation to teach in a Catholic school and teach RE. And so I've been on PD. As I said I read a lot and I just make sure when I'm teaching RE that I'm teaching the Catholic view… I think we've got a real responsibility to be doing that in a Catholic school. (I1)

Margaret cited the accumulation of knowledge through her life experience as a Catholic, her formal professional development courses, and her own professional reading. She also saw the faithful representation of Church teaching as central to her identity.

The difference between Margaret's response and that of graduate teacher Alison was stark. In answer to the same question about content knowledge in RE, Alison rated herself a 5 out of 10. She had two Year 9 Religious Education classes and when asked about how prepared she felt, she replied:

Oh, absolutely brand new to Year 9 RE. I studied at ACU [Australian Catholic University] in the city and that's the Archdiocese of Melbourne, whereas we're in the Archdiocese [sic] of Sale so the curriculum, the access to the curriculum is slightly different than what we learnt at uni. (I1)

Alison had completed a Graduate Certificate in Religious Education training at ACU, a Catholic University in Melbourne, which focused on a different curriculum to that in the Diocese of Sale in which Wayfarer was situated, and as such she felt unprepared to teach the topic on canonisation. When asked later how important teaching Religious Education was to her, Alison replied "it is unfortunately not my priority (I2). In the literature, some theorists (Magnusson et al., 1999; Ruppar et al., 2015; Smart et al., 2013) suggest a specific teacher's PCK may be shaped by their orientation towards the teaching of a domain, and it may be that this difference in orientation was as much an influence on Margaret and Alison's practice as their CK.

There were clear differences in the way each teacher approached the task of selecting videos for their classes. In the two vignettes below, both utilised the search and scroll technique outlined in Section 6.3, but Margaret used her CK to focus on the syntactic and conceptual understanding she wanted her students to gain, while Alison sought a resource simply to explain the concept because she lacked the knowledge herself.

Margaret was selecting a video for her Year 8 class to help in teaching the differences between the four Gospel accounts. Ultimately, she chose to use a series of videos by the YouTube channel *Bible Project* (V45), showing one 8-9 minute video each lesson for four lessons. Margaret recounted the conceptual understanding she planned to teach her students:

> What they were concentrating on was what the Gospels were saying and also that idea of the nuances between the various Gospels [for example] Luke and the marginalized… and just saying you now see they're similar but they are highlighting different things. That you know, the Nativity stories aren't in all of them and that sort of thing. That John's is much more poetic in a sense, and theological. So even though some of those terms are a bit hard for them just to show them that they're different but the same if you know what I mean, and introduce them to the synoptic gospels and that sort of thing. (I2)

This description highlights quite a nuanced understanding of the literary devices of each Gospel, the intention of each author, the narrative differences between the accounts, and technical terminology for the groupings of Gospels. When explaining her actions while playing the videos, Margaret recounted:

> I did stop every now and then because there were terms, you know, even referring to the line of David. Who is David? What does that mean? Why was that important due you think? And the certain references that they probably weren't familiar with they were going very quickly. (I2)

She later added that she also had to stop "to remind [the students] what messianic means… I do add bits as we go along" (I2). Margaret's pre-existing CK was central to every step of the process of her planning and instruction. When planning her class, Margaret had a clear idea of the literary differences she wanted to explore and the conceptual change that would be an indicator of success. During playback Margaret had sufficient CK, or indeed PCK, to be able to recontextualise the more technical aspects of the videos, such as the scriptural notion of the line of David.

In contrast, Alison's experience of searching for a video to help her teach the topic of Catholic canonisation was primarily in order to cover for her own lack of CK in the area. She recalled the rationale for using a video and the process of finding it in a brief exchange:

Researcher	*Let's come back to that video you were talking about on the process of canonisation. Where did you find that one?*
Alison	*Just on YouTube. I put in canonization and that was the first one to come up…*
Researcher	*So when you found yourself preparing for those lessons [on canonisation], were the videos the source of information for you*
Alison	*Absolutely yes 100%*

Researcher *So you sat down, talk me through that process of sitting down looking for stuff.*

Alison *Yeah like, is there going to be something that's going to explain this to me that'd be great, and if is it accessible to the kids then awesome yeah, absolutely. (I1)*

While Margaret had used her pre-existing CK to find a video aligned with the conceptual change she sought to promote, Alison had chosen “the first one to come up” because she was relying on it as the source of information for her lesson. Indeed, the primary reason for her search was to find a video to “explain this to me”.

The process of searching for and playing a video was different for the two teachers, with Margaret already knowing the topic to be taught in depth and the nuances of the conceptual change she sought to promote. Alison searched primarily for an explanation of the topic to be taught. Alison had trusted the content she found on YouTube to the point that it became the basis for her lesson, while Margaret had viewed the videos critically, through a lens of existing knowledge, with clear criteria for exclusion and a sufficient knowledge of the content to add to the presentation.

As will be explained in Chapter 7, the YouTube search algorithm has been shown to preference controversial material at times (Rieder et al., 2018) and as such trusting it to surface reliable content is a precarious practice. Shulman’s (1987) ideal that preparing to teach ought involve scrutinising the “teaching material in the light of one’s own comprehension, [asking] whether it is fit to be taught” (p. 16) is arguably impossible when the material itself is the source of comprehension. Indeed, Alison’s strategy conflated Shulman’s (1987) process of comprehension and transformation, “where one moves from personal comprehension to preparing for the comprehension of others" (p. 16). Shulman realised that the PR&A model he presented was aspirational, and that at times elements may be "truncated" or "given short shrift" (p. 19).

The contrast between Margaret and Alison's processes and motivations in searching for and selecting instructional videos in Religious Education is telling, because it demonstrates the important role CK plays both in the selection of videos and in planning for student learning using those videos. The use of YouTube as a support mechanism by young teachers without adequate CK is worth investigating more closely, particularly considering the prevalence of out-of-field teachers (Weldon, 2015).

6.3.2 Helen and Troy – CK empowers teachers to teach beyond the video

This section outlines the effect CK had on Troy and Helen's respective abilities to answer questions beyond the specific content of the science videos they were showing. Under the Victorian Curriculum, teachers of Science in junior years need to teach a wide variety of sub-domains within the broader domain of science, despite the teachers in this study holding degrees in one or two particular strands of the sciences. As such, a teacher with highly developed CK in one topic found themselves a novice in another. This variance in teacher knowledge is rarely described in the literature on teacher knowledge and practice, with teachers more regularly described as expert or novice (Krepf et al., 2018), experienced or pre-service/early career (Melnick & Meister, 2008), or out-of-field or in-field (Weldon, 2015).

Troy saw himself as an expert in psychology and biology, such that he reported "I was actually the only one who did a dissection in class, all of the other classes just use my [YouTube] video" (I2). In contrast, his self-declared limited understanding of physics allowed him to deliver the content as prescribed by the curriculum, but prevented him from engaging with his students beyond that narrow scope. During a Year 8 General Science class observed for this study, Troy showed a video by YouTube channel Manocha Academy entitled *Different forms of energy*. This was shown as an introduction to rudimentary physics. As part of a class discussion following the video, one student asked Troy a question about velocity and its relation to potential energy that seemingly showed an attempt to integrate the content of the lesson into his wider schema of motion - the very definition of meaningful learning according to Moreno and Mayer (2007). Troy explained to the student that he was unable to answer such a "high level physics question" (O) and moved on with his lesson. The student's question related to the Year 9-10 course according to the Victorian Curriculum (VCAA, 2015), a course Troy did not teach. Because he lacked CK, or what Shulman (1986) termed *vertical curriculum knowledge*, meaning "familiarity with the topics and issues that have been and will be taught in the same subject area during the preceding and later years in school" (p. 10), Troy was unable to teach beyond the content of the video, and was unable to use it as a mechanism by which to engage in further discussion in the way he may have been able to in the same class when teaching introductory biology.

In Helen's Year 8 General Science class, the students watched a video on digestion at their own pace (see Section 6.2 for a fuller description of the lesson). As she circulated to each student throughout the lesson, she was able to address a range of questions both clarifying the content of the video, and some seemingly unrelated to digestion. These ranged from hygiene science to the effect of Asthma on lung capacity. She answered these questions with authority and without hesitation and was therefore able to engage the students in her class in discussion lead by their inquiries. In these observations it is impossible to measure the relative general science knowledge of the two teachers, indeed given his knowledge of biology, had Troy been teaching digestion he may have demonstrated a similar breadth of knowledge to Helen. Instead, this comparison demonstrates the role of CK in allowing teachers to teach beyond the content of the video in any particular topic area. In short, a teacher with more comprehensive CK may be more able to use a video as a launching pad for student led inquiry, rather than simply as a didactic tool.

6.3.3 Dennis and Carl, CK and the YouTube platform

While YouTube was the primary source of instructional videos for all of the participants, Dennis and Carl demonstrated that CK changed the way in which the platform was viewed, and in turn the level of critical analysis videos were subjected to. Experienced teacher of History Dennis viewed the platform with suspicion, cognisant of the ways in which content in his teaching domain was often misrepresented on YouTube. He drew on the CK he had developed through extensive professional reading in order to fact check the videos he used, keen to show me his bookshelf during our first interview. In a discussion on the reliability of videos on YouTube, Dennis reflected:

> Sometimes you've got to be really careful. What I tell students is there is a massive amount out there. There is a very small amount of it that is reliable and useful, particularly as a historian. That's what you’ve got to be really careful of. When I teach the unit on the Middle East for example I caution students very, very carefully because most of what's done is either strongly pro-Palestinian or strongly pro-Israeli. There is very little that tries to present both sides. (I2)

He was sceptical of the neutrality of producers on YouTube and was guarded about what he would choose to show. Dennis’s understanding is supported by Rieder et al. (2018) who found that YouTube's algorithm preferences controversial content, particularly for politically sensitive topics like those Dennis was required to teach. As a result, Dennis was fastidious about watching videos in full before showing them, even reporting that despite having shown *The History of Israel* (V19) up to nine times he "went back and watched it again" (I2) in preparation for his class.

In contrast, second year teacher of Business and Economics Carl described YouTube as "amazing" (I1), and explained that it was a key source of his own information:

> It's just up-to-date I think. I'm a real YouTuber anyway personally, so I get so much information, whether it's documentaries, factual business information, it's got tons of case studies of companies. It's got product reviews for businesses it's got customer reviews. (I1)

Unlike Dennis who used what he saw as reliable CK coming from static texts to critically evaluate the videos he showed, Carl used the videos as a source of his CK. When asked whether there were particular producers he turned to, Carl offered:

> Definitely heaps, there's heaps out there… There's Visual Politik which is good. That's for economics that I use and that's really snappy 3-minute videos. The guy Simon Whistler is really good, [he] talks about international politics, economics, all sorts of issues. (I1)

Simon Whistler is a professional YouTuber who has branched out to start several YouTube channels that publish content daily. He recently admitted in an "ask me anything" session on Reddit that he does not have a formal background in economics or politics. He has presented on YouTube's creator studio as an expert in building watch time and channel subscriptions (Whistler, 2018) and he reports that building these metrics is the primary aim of a YouTuber. His channel relies on ostensibly controversial or confrontational titles, such as *Why does Australia FEAR China* (capitals in original), which was a video Carl reported using in class. While this does not necessarily mean the channel is unreliable, it does suggest that Whistler's motivations when producing videos are different to publishers of school textbooks.

In response to questions about his approach to the factual accuracy of the videos and producers he relied on Carl replied that "it's hard to, yeah I suppose if I had the time I would have to fact check it but, um, just at the moment I just don't have the time" (I2). Carl's answer suggests that concerns about factual accuracy were, for him, not a primary consideration and something that was only necessary 'if I had the time'. Indeed, the practices of Dennis and Carl differ primarily because of an attitude towards the importance of CK and factual accuracy, which resulted in Dennis committing more of his time to ensuring he checked the videos he used. Dennis also reported that maintaining his CK from what he saw as authoritative sources was a priority to him. So, while Dennis drew on his CK as a tool by which he excluded and selected various instructional videos, this was a result of a conscious decision to preference CK.

6.3.4 CK - summary

The three comparative vignettes presented in this section highlight three impacts of CK on the selection and use of instructional videos, addressing the first sub-question. Shulman (1986) lamented that CK is often a "missing paradigm" (p. 7) when examining teacher knowledge, when it is fundamental to effective pedagogical reasoning. This section supports his assertion, demonstrating through a series of three comparisons that CK empowered teachers to select accurate and effective instructional videos. Shulman (1986) argues that teacher knowledge needs to go "beyond knowledge of the facts or concepts of a domain" (p. 9) but this study reveals that at times teachers lack even this most basic level of CK. The lack of such knowledge impedes the ability of a teacher to select reliable instructional videos, to teach beyond the boundaries of the sources they choose, and may encourage time-poor teachers to turn to potentially unreliable sources to address their lack of knowledge. Alternatively, teachers with high CK were able to critically evaluate videos, interpret content for students, and answer questions that went beyond the scope of the video.

First, the experiences of Margaret and Alison show the impact CK can have when planning to teach with instructional videos. Margaret drew on her CK when determining the video's accuracy, but just as importantly when considering the conceptual contribution of the resource in her teaching sequence. Because of her lack of CK and the low importance she placed on the teaching of Religious Education, Alison used "the first one that came up" (I1), trusting that the video presented accurate and conceptually appropriate instruction.

Next, through the observation of Troy and Helen's classroom practice, the role of CK in allowing a teacher to move beyond the boundaries of the video during instruction was demonstrated. A knowledge of the broad domain within which the topic to be taught is situated allowed Helen to answer divergent questions, but Troy was unable to assist the student in making connections between prior knowledge and the topic at hand. The reflections of the General Science teachers in this study suggest that maintaining a broad knowledge about the wide range of topics they are called on to teach would be difficult. This casts doubt over how realistic Shulman's (1986) demands of what teachers "must understand" (p. 9) are, including that they be as knowledgeable as non-teacher experts. Regardless, this study reveals that when such broad knowledge exists, it facilitates teachers using instructional videos as launching pads for inquiry and student-led discussion.

Finally, the comparison between Dennis and Carl revealed the influence of CK on the use of the YouTube platform. Because of his well-developed CK honed through other sources, Dennis viewed the YouTube platform critically, acknowledging that very little of what was published in his domain presented a balanced view. He was, therefore, fastidious in watching videos through, and fact-checking them prior to showing his class. In contrast, Carl saw YouTube as an important source of his CK. This led him to use videos in class that he had neither fact checked nor viewed in their entirety.

The finding emerging out of this study that instructional videos may be used by early career teachers like Carl and Alison or those with low CK like Troy as a source of knowledge when forming their comprehension of a topic prompts an important discussion about the role that video producers have in passing on knowledge. Indeed, teachers using YouTube videos as a source of instruction outsource the need for substantive or syntactical knowledge of the content to the video producer. While there is little doubt teachers with low CK have been doing this with textbooks for generations, such texts are usually written with editorial oversight, and chosen by school leaders or leading teachers. Holmberg et al. (2018) point out that using online sources means "the lack of a publisher guaranteeing the quality of the teaching material" (p. 134). While research into YouTube content accuracy has so far been limited to medical topics, and some content like the *Crash Course* series is indeed backed by a team of researchers, it seems likely given the low revenue generated by relatively low view counts on education channels (Bärtl, 2018) that such publisher oversight is not ubiquitous. While in the Holmberg et al. (2018) study, all of the teachers had highly developed CK and so materials chosen were filtered through their expertise, this study shows teachers with low CK also at times turn to these unverified sources.

The next chapter contains a more thorough discussion of the nature and influence of the YouTube platform.

6.4 PCK/TPACK

As has emerged in the analysis so far in this chapter, it is difficult to discuss teacher knowledge types in isolation because pedagogical reasoning results out of a complex, sometimes subconscious confluence of knowledge. Shulman (1986) proposed the existence of PCK, a specific "categor[y] of content knowledge" (p. 9) that describes how particular content is best taught. When the technological aspects of applying PCK to the pedagogical use of an emerging technology are foregrounded in a teacher's reasoning it can be described as TPACK, which Phillips and Harris (2018) describe as a special case of PCK. While this argument that TPACK is a special case of PCK is not widely represented in the literature, it recognises the sliding nature of TPACK (Cox, 2008; see also Chapter 2) in that TPACK fades to PCK as technology becomes more transparent for the teacher. In this study, the knowledge teachers drew on at times foregrounded the technological while more often the technological was transparent.

Three clear trends emerged as to influence of PCK/TPACK on the selection and use of instructional videos. First, subject domain was found to influence the perceived utility of videos, and the type of videos chosen. In short, teachers saw videos as more or less useful in teaching *particular* topics, rather than in general. Second, PCK emerged as key in the teaching practice of contextualising content by adding explanations to videos live when they presented too much information or used confusing terminology. Finally, consistent with previous studies (Júnior & Fernandez, 2013; Krepf et al., 2018), this section reveals that experience teaching a subject tended to correlate with well-developed PCK/TPACK, insofar as experienced teachers reported, and were observed enacting more purposeful integration of instructional videos into learning activities. This is unsurprising, given the findings from previous studies which indicate “teachers acquire pedagogical content knowledge from actual classroom experience” (Grossman, 1990, p. 15).

6.4.1 A comment on the sliding nature of TPACK

Cox (2008) argued that TPACK becomes PCK when the technology being used becomes transparent, or ubiquitous. In other words, when teachers become adept at using a technology for learning, it becomes yet another tool in the “armamentarium” (Shulman, 1986, p. 9) of teaching, and therefore the knowledge used is once again PCK. Cox (2008) presented this movement as a unidirectional transition from TPACK to PCK that shows arrows moving from TPACK to PCK and not vice-versa (p. 74).

This study, however, suggests that teacher reasoning using instructional videos can at times be TPACK, such as when considering the affordances of videos over text, and at other times PCK, such as when selecting a particular video based on considerations of the particular content to be taught to particular students. This is because the technological aspect of the knowledge is foregrounded or backgrounded. When selecting videos from the YouTube platform, the teachers described the process with such casual terminology, even using ‘YouTube’ as a verb, that the search and scroll method could be seen as evidence of taken-for-grantedness (Edwards, 2015). It seems possible then, that technology can sit in a liminal space, both transparent and taken for granted depending on context and thought process. Arguably it is not the technology that becomes transparent when TPACK becomes PCK, but, drawing on a view of long-term knowledge from CLT, the knowledge that becomes automated, meaning that the TK is backgrounded. There are times when this taken-for-grantedness can become problematic, because teachers can fail to see the impact technology is having on their practice. This is what Edwards (2015) calls “human software entanglement” (p. 265). It may indeed be that in the practice of some teachers technology becomes transparent prematurely, prior to the development of an appropriate knowledge base. This is addressed in more detail in Section 7.2.

6.4.2 Subject domain influence on video use

There were some interesting trends in overall enthusiasm and use of instructional videos between teacher subject domains (Art, Business Studies, Economics, English, Religious Education, Mathematics, Science, and History; see Table 11). While this stands in contrast to other studies that have found differences in technology use based on age (Christ et al., 2017; Holmberg et al., 2018), it supports the finding in the literature that a particular affordance of instructional video is visualising hard to explain concepts (see Section 3.1.4). Two participants, Alison and Margaret, who expressed low enthusiasm for technology attributed their perspective to their work as English teachers. Alison said plainly that “English teachers, we’re paper people” (I1), highlighting the role of identity and values in influencing teacher decision making (Gudmundsdottir, 1990). Tellingly, their enthusiasm for the use of instructional videos was higher when discussing their work in their other subject domains, Religious Education and History. For example, Margaret reported using no instructional videos in her English classes but spoke extensively of those she used in her Religious Education classes. The remaining teachers in this study, who professed a greater sense of confidence and enthusiasm towards instructional videos (and technology generally) tended to teach in domains of greater declarative certainty, such as Science, Business Studies, Mathematics, and History. Highlighting the particularly content-bound understanding of the affordances of technology in TPACK (Mishra & Koehler, 2006), the teachers of these subjects also identified specific affordances of video that helped teach these subjects.

Table 11

Videos Used by Participants in each Subject Domain

	Alison	Carl	Dennis	Helen	Louise	Lucy	Margaret	Melissa	Troy	*N*=58
Art	-	-	-	-	-	3	-	-	-	*3*
Business Studies	-	5	-	-	-	-	-	-	-	*5*
Economics	-	4	-	-	-	-	-	-	-	*4*
English	3	-	-	-	-	-	0	-	-	*3*
Literature	-	-	-	-	-	-	1	-	-	*1*
History	-	1	5	-	-	-	-	4	-	*10*
Maths	-	-	-	0	1	-	-	-	-	*1*
Religious Education	2	-	-	-	-	-	3	2	-	*7*
Science	-	-	-	11	6	-	-	-	7	*24*
N=58	*5*	*10*	*5*	*11*	*7*	*3*	*4*	*6*	*7*	

The three teachers of Science (Helen, Louise, and Troy) all reported using instructional videos when a phenomenon in the curriculum was either unsafe to replicate in a classroom, or at a scale too large or small to display. At Station, Helen preferred to allow students to learn from experiments firsthand, but turned to videos like Sky One's *Brainiacs* (V26) and BBC's *The Elements Explained* (V23) when exploring volatile materials like caesium and rubidium. She explained that “they are beyond the risk factor but it's still worth them knowing that this is how this stuff behaves” (I1). At Wayfarer College, Louise also cited safety, but added scale, in particular “microscopic things that we don't have the facilities or equipment to be able to see… can have a big impact on kids” (I1). This shows the role of TCK in TPACK. Echoing research suggesting that videos are most effective at teaching procedural motor tasks (Höffler & Leutner, 2007), Helen saw a particular use for videos in introducing safety procedures not required in less practical subjects:

> At the start of every year, the kids have a sheet of paper that has the lab rules and they're supposed to do a ‘fill in the gaps’ thing that I've redesigned because it says ‘do you know where to find the fire extinguisher’ and I thought, this is ridiculous, they point to the fire extinguisher at the front of the room they write down ‘it's at the front of the room’ but none of them would know how to use it if a fire broke out and I happened to be the one on fire. I actually want them to be able to tip it upside down and point it at me! (I2)

Helen’s response demonstrates her view that the existing text-based safety instructions were inadequate and that a video showing how to use a fire extinguisher (V27-29) was more likely to lead to effective practice if the need arose, a skill she had a personal interest in the students acquiring!

A central element of PCK is an understanding of the difficulties inherent in teaching some topics, and the best ways of overcoming those difficulties (Park & Oliver, 2008; Van Driel et al., 1998). Some concepts and phenomena are more abstract or difficult to demonstrate than others, and the Science and History teachers in this study in particular reported that these prove difficult to teach using the usual materials available within the classroom. In these instances, instructional videos offered “newer and more complex representations of content, the idea at the heart of TCK” (Mishra & Koehler, 2006, p. 1040). At Wayfarer College, Troy argued that when teaching DNA transcription, “there is no other way you can demonstrate that apart from using a video” (I1). While perhaps hyperbolic, Troy highlighted that such scientific topics are hard to represent using the usual materials available to a teacher and benefited from animation. Going on, he explained:

> Plate Tectonics (V54) is the main one that really benefits from animations. You can sort of do motions with your hands and show your hands moving together to show a convergent boundary in a way or for a divergent boundary, but to actually see it superimposed on the earth and actually see the Earth itself and what's inside the earth and all that, you do need an animation for that. It's just, yeah, you're limiting yourself otherwise. (I1)

Troy’s opinion that “without a video” his best representational technique was his hands (which he was moving as he was talking) highlighted his understanding that animations are particularly powerful in communicating large scale dynamic processes. Troy saw that science teachers not using animations for such phenomena had “limited themselves” demonstrating his opinion that instructional videos have become a key tool in the “armamentarium of alternative forms of representation” (Shulman, 1986, p. 9).

At Station College, experienced Science teacher Helen also saw videos as particularly helpful in teaching topics if and when physical, experimental learning was impossible:

> I don't do a lot of videos when I'm doing chemical reactions but I'll use a lot of videos with body systems, because no one's going to give me a half a dozen cadavers for the kids to play with. No one would think that that was responsible. So, it depends on what's being presented as to whether there is an appropriate video and whether it's even needed. I'm teaching light and matter to Year 12 and it's easier to

> talk about emissions by them burning stuff and seeing through a spectroscope and seeing the lines than me bringing up a YouTube of somebody looking through a little black box and showing what they see. Videos are not going to replace that hands-on thing. (I2)

This reflection shows Helen's nuanced TPACK, in that she saw the benefits of instructional videos, but did not see them as a panacea or appropriate for all circumstances. Indeed, she saw them as secondary to technology such as a spectrometer, because of her view that involving students in the physical exploration of Science was superior to watching others, a view supported in other research (for example, Eisner et al., 2012). Unlike the early career Business and Economics teacher Carl who thought that videos could be used "for any class" (I1), Helen identified what she saw as a hierarchy of pedagogical activity, explaining "my focus is on active learning. I want students to 'do first' in science. If they can't do, then a video comes next in terms of engagement and learning" (personal communication 11/9/2019). She explained that this belief was a result of reflecting on her own childhood experience of school:

> Wherever it's affordable, possible, and safe to do I'd rather than do it than watch it, but that's because it's the experience that you'll remember. I still remember in Grade 2, that was a long time ago, when the inspector still came out to schools so the teacher needed a whizz bang lesson. It's the only lesson I remember from Grade 2, but we cut open an eye… I distinctly remember doing that and that's why I, possibly why I, became a scientist, a science teacher, because it made sense to me. I could see the lens, I could see through it and now that's the experience that I want for the kids that I teach. (I2)

It is an interesting aside to note that both Carl and Helen preferenced the approaches they had benefited from in their own learning experience. For Carl, who declared that YouTube was a key source of his own information "whether it's documentaries or factual business information" (I1), videos were an important part of "almost every lesson" (I1). Whereas, for Helen, who remembered so vividly learning from hands-on activity, she preferenced these activities in her class, using videos only when hands-on activities were impractical. While Shulman (1987) does not discuss the influence of a teacher's own experiences as a student when enumerating the four main sources of teacher knowledge development, Lortie (1975) described such experiences as the "apprenticeship of observation" (p. 64). By this, Lortie meant that memories of their time spent learning in formal settings provide teachers with examples of how to teach, and how students learn, that are, for better or worse, "difficult to overcome" (Grossman, 1990, p. 10). In this instance, Helen had remembered the practice of her own primary school teacher, decades earlier, as what Shulman (1986) would call a prototype case, or a case communicating a theoretical principle - the superiority of hands-on learning in Science classes. The very limited data in this study suggests there is room for more research on the influence of teacher experiences of learning on their beliefs about teaching practice.

Returning to discussion of concepts that are difficult to portray, Margaret described the difficulty of teaching foetal development in the context of ethical debates around abortion in her Religious Education class:

> There are a couple of different videos on foetal development and I find that's important, because it's an abstract term to a lot of them, abortion. They don't understand the heartbeat you can see very early on, all those sorts of things… And it makes it a bit more concrete for them. (I1)

Interestingly, in her Religious Education class, it was the hidden scientific process of foetal development, rather than ethical arguments that Margaret reported videos being useful to teach (see V43), echoing the conclusions of Brame (2016) that videos are “well suited to illuminating the abstract or hard-to-visualize phenomena” (p. 1). This suggests that even within a Humanities subject, a video may be particularly useful to demonstrate scientific phenomena. Margaret’s knowledge of student misconceptions, and the appropriate technology to assist in representing it to students represents a clear example of TPACK, in which the particular technological affordances of instructional videos is seen in light of its specific ability to help teach a particular topic to particular students.

For teachers of History, a particular type of knowledge which is impossible to generate after the fact is firsthand eyewitness knowledge of real phenomena or events. Dennis saw great benefit in showing his senior History students footage of historical figures explaining the events the students were studying. He explained a particularly impactful video eyewitness (V20):

> I know one of the things that engaged the students most in the Cuban Missile Crisis video was interviews with Fidel Castro. Now this is Fidel Castro being interviewed in the 1990s, and his viewpoint on what had occurred was really amazing and he was clearly very, very pissed off. Still, Russia didn't consult him about pulling the weapons out. And you could see him, he gets angry, he gets off his seat and goes up like that. And a student said ‘so he’s still pissed sir!’ (I2)

The effectiveness of this video was largely because of the emotion Castro showed when discussing the withdrawal of Soviet weapons. In another example, Dennis described that students saw the Holocaust in conceptual terms, but understood that “it’s not just words” (I1) after witnessing survivor testimony in the BBC/PBS *Master Race* documentary (V18).

Highlighting this effect of subject domain on video use, 4 of the 6 videos Melissa reported using were in her two History classes, despite these constituting only a quarter of her classes. Like Dennis, she described the power of eyewitness accounts in conveying emotional information that she had failed to convey using other means:

> In my rights and freedoms class we talked about Emmett Till who was an African American kid who ends up getting bashed and killed. And his Mum puts his body in a casket and has an open casket to then get filmed and put in the newspaper. I had had no reactions to the entire American Civil Rights Movement. Nothing. They didn't care, and then all of a sudden, I showed them a picture of his head and we watched a newsreel (V48) and we watched the mother talking about it and it hit them straight away. It was incredible, and now they care. (I1)

Melissa went on to explain that this video footage was “helping them make the connection between what they've read and the reality” (I1). Melissa did not see the video as the only means of instruction, explaining that:

> We had already discussed it, and I'd kind of gone through what the cause was and we were starting to look at what the consequence of this murder and the mother's choice to have an open casket at the funeral. And then we watch this newsreel because the newsreel was about what impact that then had on the ruling and that kind of thing. So, it was kind of building on what we already discussed but then yeah, to get that gut-wrenching reaction. (I1)

Rather, the video (V48) acted both as an additional instructional source and as a device to break through emotional apathy after which the students became engaged in their historical enquiry. Melissa’s experience lends support to the ICALM model (see Section 3.4.2) which postulates that multimedia can attribute affect, or mood, which leads to interest and affects the effort students are willing to commit to cognitive processes. In her view, without the multimedia source that conveyed the emotional reality of the historical event, her students would not have cared, and therefore would not have learned as much as they did. Melissa and Dennis's reasoning suggests that videos, given their ability to convey tone and emotion, are useful in portraying the complex realities of human experience that text may not convey.

Importantly though, this use of video to display actual historical footage is content-specific. It is limited even beyond the domain level, as most historical events occurred before the advent of video cameras or were not filmed. For instance, while dramatisations of ancient history may exist, there is no newsreel footage of the Battle of Hastings. Future research may investigate the relative effect of actual footage in contrast to dramatisations on student affect.

These examples point to the very subject specific nature of PCK/TPACK (Van Driel et al., 1998) and suggest that instructional videos may be more pedagogically valuable to teachers of some subjects than others. This supports the view of Mishra and Koehler (2006) who argued that "not every topic can be shoehorned into any technology and, correspondingly, any given technology is not necessarily appropriate for every topic" (p. 1040). While this is not a quantitative study, and the sample is not evenly distributed among subject domains, it is interesting to note that 34 of the 58 videos mentioned by teachers were used in Science (24) or History (10) classes, whereas only three were used in English classes (see Appendix G for a full list of subjects). Such disparity deserves further investigation, and highlights that content independent guidelines for the use of instructional videos, as have been proposed through CTML (for example, Mayer et al., 2020) are problematic. This is particularly important given the finding in the systematic review conducted for this study (see Section 3.5) that Humanities subjects, and English in particular, are vastly under-represented in the experimental literature, which is dominated by videos with a STEM focus.

6.4.3 Bridging, Contextualising, and a preference for projectors

This study contributes the term *bridging* to describe the actions of teachers, through explanations, discussion, and questioning, to make the content of a video that was not specifically created for the class relevant to the particular learning aim of students and the curriculum. This may include *contextualising*, in which a teacher explains how the examples in the video, which are different to the curriculum, may apply to their learning goals. Teachers in this study rarely found videos perfectly aligned with their teaching aims, instead choosing a best fit from those surfaced by the YouTube search tool. Teachers then re-purpose these videos for their classrooms.

Bridging happened at various stages of playback, but was most prominent at the start of each video, when teachers would almost always outline the learning intention from the video, pose a question, or provide any key knowledge students needed in order to contextualise the content. Before showing the *History of Israel* video (V19), Dennis posed a big question "why did conflict occur" (O) and guided student attention towards key aspects: "I'll try to pause it whenever the map comes up, watch out for bias" (O). When showing the sculptures video, Lucy outlined the purpose of watching "to show you some examples to give you ideas" so that students focused on the form of the sculptures rather than the historical information about each. Melissa explained the purpose behind these introductions, highlighting the need to direct student attention:

> I put a lot of emphasis in telling the students ‘we're watching this video because’ or like I said I'll have a question or some ideas that I want them to gain from the video up on the whiteboard so they can see it and we'll discuss that prior to watching it. I will never just watch a video and say alright now we're going to talk about it because they don't know what to talk about, and they don't know what to analyse, and they don't know what to say. Whereas I feel like just having a preamble or an idea of what they're searching for then there's a purpose to watching it and they understand but this is useful. (Melissa, I1)

This activity of bridging shows that teacher use of videos in this research was rarely a passive pursuit, as has been observed in past studies (Hobbs, 2006; Krauskopf et al., 2012), but an active engagement between teacher, students, and the media. It should be noted, however, that as Shulman (1987) recognised, “there are powerful relationships between the comprehension of a new teacher and the styles of teaching employed” (p. 17). In this study, the greater a teacher’s CK, and the more deliberate the choice of video, the more nuanced and precise the bridging activities tended to be. This study showed that bridging relied on the experience and demonstrated PCK of the teachers.

Alison, who reported knowing little about the canonisation process of the Catholic Church used the *Busted Halo* (V2) video as a direct replacement for her direct instruction in her Religious Education class and reported using little additional bridging input. Carl did not have a clear understanding of the guerrilla marketing video he showed in his Business Studies class, and so was unable to bridge the gap between the video and his teaching goal, appearing to leave himself and his students confused. Troy was able to bridge the gap between the imperial units of measurement used in the *Manocha Academy* video (V57) and the metric measurement that was required in the Victorian curriculum by providing students with real-time calculations, but was unable to go beyond the specific teaching goal to answer a student's question, because of his lack of "high level physics knowledge" (O).

On the other hand, Helen and Dennis, with their well-developed PCK and intimate understanding of the video content they chose, were able to engage deeply with student questions arising from the videos they showed in History and Science, adding detail and simplifying concepts where needed. In particular, Dennis used the clear bias of the *History of Israel* (V19) video as a teaching tool, regularly pausing the video to explain the contested nature of Middle-East politics using examples from the media. Louise was able to tell students when to pay attention and which parts of the *Crash Course Biology* video (V33) to ignore, because it went beyond her teaching aim and she knew it might overload or intimidate students. This is evidence that PCK is not made irrelevant by the use of videos, nor is its use exhausted in the selection process. Instead the expertise of teachers allows them to take content that would have limited use in isolation and re-purpose it to make it "fit to be taught" (Shulman, 1987, p. 16).

Bridging and contextualising, including pausing to add insights, check for understanding, answer questions, encourage discussion, or clarify content emerged as important reasons that teachers preferred a communal screen over allowing students to watch on individual devices (see Table 12). Indeed, despite the findings in experimental studies that learner control during playback, tends to lead to greater learning outcomes (Hasler et al., 2007; Höffler & Schwartz, 2011; Mayer & Chandler, 2001; Tabbers & de Koeijer, 2010) Table 12 shows that 51 of the 58 videos teachers reported using were displayed on a shared projector screen. Of the remaining 7, students used their personal devices to watch the videos in class only 3 times, with the other 4 set for homework. While for some of the teachers, projectors were primarily preferred for classroom management reasons (see Section 7.1.3), more experienced teachers tended to cite bridging and contextualising practices as their key justification.

Table 12:

Control of Playback

Participant	# Videos	Learner Controlled *n* (%)	Class Projector Screen *n* (%)
Alison	5	*0* (0%)	*5* (100%)
Carl	10	*1* (10%)	*9* (90%)
Dennis	5	*0* (0%)	*5* (100%)
Helen	11	*1* (9.09%)	*10* (90.91%)
Louise	7	*1* (14.29%)	*6* (85.71%)
Lucy	3	*1* (33.33%)	*2* (66.67%)
Margaret	4	*0* (0%)	*4* (100%)
Melissa	6	*0* (0%)	*6* (100%)
Troy	7	*3* (42.86)	*4* (57.14%)
TOTAL	58	*7* (12.07%)	*51* (87.93%)

This was particularly the case when using videos that were less closely aligned with the curriculum or learning goals of the teacher or were potentially confusing. Dennis explained that:

> I would say a well-constructed documentary is generally one that students can do more independently [whereas] something that you might actually be using instructionally that wasn't intended to necessarily be used that way… that's the type of thing where yeah, you need a lot more scaffolding and where as a teacher you're

> monitoring the class. Sometimes the students just accept 'what on earth did that mean?' Or you'll just look around and you'll see the looks on the faces that they're rather quizzical or blank and you go 'okay there's a point where I need to intervene' and 'Okay what did you know about this?' Are they actually picking up what you'd like them to pick up? (I1)

Dennis here identifies a fundamental ability of teachers that is lacking in the video playback platforms currently available, namely the human ability to respond to the feedback and affective states of students. Dennis identified subtle feedback cues such as 'the looks on their faces' born out of his experience.

This live input and student monitoring were demonstrated when, during the class observation, Dennis paused a video on the Arab-Israeli war several times to answer questions and engage in discussion with his senior History students. He said that these questions "might not have occurred to some students" (I2) had they watched at home. This reflection mirrors the findings of Senchina (2011) who found that university students learning how to interact with subjects in human trials from example videos "often remarked that they didn't notice something that another student mentioned during large-group discussion" (p. 267). Dennis was aware of his own well-developed PCK with regard to this topic, and from past experience teaching from the same lesson plan he said he knew students would have questions. This PCK, and his self-awareness of it, motivated Dennis's decision about how to display this video.

In addition to the ability of teachers to pause videos to answer questions or re-engage students, Margaret added that videos she selected often assumed knowledge of vocabulary or prior conceptual knowledge that was beyond the experience of students and that a teacher's role included constant monitoring of understanding, and anticipation of misunderstanding. The following is an excerpt of a discussion around why Margaret chose to use the projector to control playback of a video on the Gospel of Mark (V45) in her Religious Education class:

Researcher *And were they to watch this on their own, how effective do you think it would be?*

Margaret *I don't think it would be as effective for Year 8s. Perhaps year 10s yeah. It's because even though it's sort of interesting and busy and whatever the concepts are very deep, they're very difficult and certain as I said certain things need to be explained because you know how kids are they'll just hear a word and they think of it in a different light. Think of it in a modern context or whatever.*

Researcher *So you knowing what you know about the students, you might predict a misconception?*

Margaret *Correct. Correct… For example, say it's a term that's used scripturally or within our faith but it also has a common usage.* (I2)

Margaret drew on her knowledge of her current learners, her CK and the kinds of misconceptions she had seen students make in the past – in short, her PCK – to justify her use of the projector (see Table 12). Her reference to the ways in which students misunderstand words also indicates a tacit understanding of the finding that unless student misconceptions are actively addressed videos can reinforce pre-existing misconceptions (Muller, Bewes, et al., 2008). Margaret went on to give the example of a reference to "the line of David" (I2) which was key to understanding the video, but of which she assumed her students would have little knowledge. She paused the video to add a brief explanation, bridging the gap between the video and the student's prior knowledge.

Shulman (1986) describes the kind of knowledge Margaret drew on, particularly the insight that students often wrongly interpreted scriptural language through a modern lens, as PCK:

> Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons. If those preconceptions are misconceptions, which they so often are, teachers need knowledge of the strategies most likely to be fruitful in reorganising the understanding of learners, because those learners are unlikely to appear before them as blank slates. (p. 9)

Because Margaret's PCK was combined with her knowledge of the affordances of the class projector technology, to allow her to add explanatory interjections, this knowledge became TPACK. Again, this shows both the difficulty of describing knowledge types in isolation, and the reality that pedagogical reasoning with technology is context specific.

Ultimately, teachers tended to prefer a communal projector to engage in bridging, or to maintain classroom control. This finding means that for these teachers learner control, a key affordance of videos identified in the case study literature (see Table 1, Section 3.1.4), was rarely exploited.

6.4.4 Incorporating videos in learning activities

One of the most reliably established principles in the instructional video literature is that videos should be accompanied by appropriate learning activities rather than simply displaying the video alone (Cheon et al., 2014; Delen et al., 2014; Mayer et al., 2020; Szpunar et al., 2014;

van der Meij, 2017; Vural, 2013). Indeed, Szpunar et al. (2014) found that simply showing a video alone can lead to overconfidence in learners, who can be deceived by the fluency of video instruction into believing they have understood more than subsequent tests suggest is true. Because TPACK describes the knowledge teachers need to utilise particular technologies to teach particular content to particular students, the purposeful integration of videos into meaningful learning sequences was seen as evidence of developed TPACK in this analysis.

Past research (Júnior & Fernandez, 2013; Shulman, 1987) has shown that teachers develop their PCK over their careers, in particular in the first three years. However, the use of instructional videos involves new technologies such as search platforms and video embedding tools to which younger teachers may have had more exposure. It was interesting to see, therefore, that self-reported ability with technology bore very little relationship with the fluent integration of instructional videos into learning sequences. Instead, consistent with research into PCK, experience teaching a subject was a greater predictor of this measure of TPACK. What Shulman (1987) observed in his early work on PCK was replicated here, namely that “the knowledge, understanding, and skill we see displayed haltingly, and occasionally masterfully, among beginners are often demonstrated with ease by the expert” (p. 5). Importantly, a perceived lack of time acted as an important blocker to teacher preparation of learning activities when using videos, but this reality is discussed in more detail in Section 7.2.1.

At the most basic level of video integration, most teachers in this study encouraged the students to engage in active processing or recall of the video content during or following video playback, either in the form of guided notes (Margaret), the use of worksheets (Dennis, Melissa, Troy, Louise, and Helen), games (Helen), or carefully guided discussion (Lucy, Dennis). Only Carl expressed that “I just don't have the time to create worksheets” (I2), and so was observed showing videos in isolation. For the other teachers, while most of these enhancements took the form of traditional paper and pen or class discussion activities, there were rare examples of teachers using online tools to enhance videos. For example, Helen used the competitive class quiz generator *Kahoot* to both gamify the watching of the video and to efficiently gather feedback on student understanding. She explained:

> Kahoot will let you embed a YouTube clip at the start and then have the game 'questions' follow, and this seems the most successful format, and gives me feedback as to how much the students took in from the clip. Short clip, short multiple-choice Kahoot, move on. (personal communication, 11/9/2019)

There is a clear focus on efficiency in this statement, and the key affordance of Kahoot was the ability to get feedback quickly and move on. This focus on efficiency was a common theme. For example, while Melissa and Lucy suggested they had used ClickView's video enhancement tool, which allows teachers to insert questions into video playback, they were unable to remember which videos these were, suggesting it was a rare practice.

These practices tended to be focused on ensuring or evaluating comprehension of the video material. For the less experienced teachers in this study, the incorporation of videos into learning activities was limited to short activities involving brief discussions or worksheets, before moving on to other activities. They were often seen as a break from the usual teaching routine or as a way to present a short part of the course content in a way that students enjoyed. There were, however, examples of more complex video integration drawing on well-developed PCK shown by the more experienced teachers. Two of these (Dennis and Lucy's observations) have been chosen for particular analysis, as they reveal the depth of knowledge required to integrate videos effectively into learning sequences. One further example (of Helen's practice) is discussed as it displays the development of new TPACK and its highly context-bound nature.

6.4.4.1 Dennis and the 1948 Arab-Israeli War

A lesson discussed several times in this thesis already deserves particular attention with regard to the deliberate pairing of videos with learning activities. The observation notes taken during Dennis's 75-minute class introducing the 1948 Arab-Israeli War detail a rich example of a video (V19) that did not stand in isolation but was, rather, integrated into a coherent learning sequence.

Dennis's small class of 9 students (out of a usual 12) starts with the students producing their homework assignments on the 1917 Balfour Declaration, a key piece of background knowledge to the 1948 war. This is evidence that the lesson has not been constructed hastily, but that during the previous lesson Dennis provided students with a task that in theory has prepared them with knowledge needed to understand today's learning goal. In CLT/CTML, Mayer and Pilegard (2014) have labelled this practice *pre-training* and it serves to reduce the number of novel elements in the learning, therefore making cognitive overload less likely.

The lesson continues with Dennis posing a guiding inquiry question, "why did conflict occur" (O) and addressing some misconceptions he knows to be common in students from teaching the same lesson around seven times previously (I2). For example, he explains that the Jewish people sought a home in Palestine prior to the Holocaust, not only as a result of it. Knowledge of such common misconceptions is a key element of PCK (Barendsen & Henze, 2019). Furthermore, Muller, Bewes, et al. (2008) found videos that dispelled common misconceptions prior to delivering content were more effective than those without. Dennis effectively engages in dispelling misconceptions live, showing again the kind of real-time additions teachers can make to non-bespoke videos. Dennis then moves the whole class to view a map at the back of the room where he briefly explains the Ottoman Empire. Next he introduces a group learning task involving mapping the partition of Palestine. It mixes a hard copy worksheet with online information shared with the students via Google Drive. The students are tasked with creating a mock partition of Palestine based on the information provided. When they finish, Dennis shares their ideas using his wireless device, which is mirrored on the projector.

Dennis only now introduces the video (V19), called *A Brief History of Israel*, as a way to answer the overarching question raised by the activity, namely how attempts were made to partition the land without causing conflict. The students are directed to find a companion question sheet on the class Google Drive. Dennis prompts the students to take notes, signalling the important content by announcing “I’ll try to pause it whenever the map comes up, and watch out for bias” (O; see Section 4.4.2). The video is skewed towards the Arab perspective, and during our interview later, Dennis describes it as:

> A very biased video and it's deliberately doing that and it sometimes is one of the best ways to start something is actually to give something that's really skewed and then you unravel it as you're going on because it makes [the students] ask really hard questions about it. (I2)

During playback, Dennis pauses the video six times, three to allow students to record information from a map that changes throughout the video, and three times to engage in discussion and questioning. This means the ~10-minute video is segmented into seven parts, and takes a total of 15 minutes in class to watch. When the video finishes, students are eager to ask further questions, including comparing what they had just seen to a prior unit they had studied on the Holocaust. Dennis questions the students about the source they have watched, asking "is it as straightforward as this video presents?" He goes on to prompt the bias of the video – "who did you not hear from?" (O). These questions show that Dennis is treating the video itself as a historical artefact, as well as a source of content. After this discussion runs its course, Dennis moves on with another related part of the unit before the bell rings ending the lesson.

Dennis's effective use of the instructional video drew on his well-developed PCK, built over the course of teaching this lesson on approximately seven previous occasions (I2). His lesson was planned around a central question, and involved students actively constructing knowledge through prediction followed by a critique of the video, rather than as passive observers. Dennis's PCK included knowledge of possible misconceptions meaning that, during pauses, he was able to explain the content of the video in multiple ways in response to student questions, using metaphors, and referring to materials outside of the boundaries of the course. Ultimately, his PCK allowed Dennis to transform the video from a source of content to part of a powerful learning sequence.

6.4.4.2 Lucy and Year 8 sculpture design

Observation notes from the Year 7 Art class of 30-year veteran teacher Lucy also showed evidence of the impact of well-developed PCK on the use of instructional videos. Her class of 25 students starts with an introduction to the activity that will follow the video, and therefore signals both the information the students will need to attend to and the conceptual understanding expected. Among her initial comments, I note her saying:

> I have just a short clip to watch first… I wanted to show you some examples to give you ideas… You'll see some great examples of sculpture… This is only a short clip,

> it goes for seven minutes… After the video, you will discuss in small groups. I want you to be able to discuss your favourite. You will notice how some artists pick up a theme. [turning to address two students talking to each other] You need to listen so you know what to pay attention to. (O)

Without this introduction, the video could easily have been viewed as entertainment, but this contextualising introduction was designed to focus the viewing. By restricting the amount of information each student was required to recall to just one of the 23 sculptures outlined in this video, Lucy showed an understanding of the limitations of her particular students. The students were aware of ‘what to pay attention to’.

Lucy dims the lights using a panel near the door, and starts the video, entitled *23 sculptures you won't believe exist*, a video she has not used before, and found “3 or 4 months ago when I knew I was going to do a 3D [sculpture]” (I2) using the search and scroll method. The video plays through uninterrupted and the students watch, laptops closed at Lucy's request to “stop distraction” (I2). At the end of the video YouTube auto-plays a prank video and Lucy scrambles to stop it. She says it always happens and it is exacerbated by the fact that she runs a split screen, meaning she struggles to press stop in a hurry. This is a feature of YouTube that can be disabled, and Lucy's response suggests she does not know this, indicating her TK concerning YouTube is not particularly well developed, but this does not affect the lesson in any discernible way.

Lucy invites students to spend a few minutes preparing their response by discussing in small groups while she plays the video again with the sound turned down. Lucy then leads a 9-minute discussion during which each student speaks in turn, engaging with Lucy for around twenty seconds. Some of the students have looked up their chosen sculpture on their laptops to gain more information, a practice Lucy praises. During the discussion activity, Lucy attends closely to the words of each student, drawing out their reasoning and highlighting when they referred to the video.

At the conclusion of this discussion, Lucy explains that each of them is to design and create their own sculpture. She brings out practical materials and briefly demonstrates some techniques using wire. Lucy then announces that “you may look up your own clips to help” (O) and while working several of the students use YouTube to find how-to videos. Later, Lucy reflected “there were a couple like [student x] who went really technical and got this really intricate video about how to make a bicycle and he started to do all the little parts” (I2). She explained that independent use of YouTube to find art technique videos was “standard practice” (I2) in her class. Interestingly, this contrasted with Dennis’s advice to his students to be very careful of the content on YouTube. It may be that the content for different subject areas on YouTube display varying levels of reliability, a question deserving of further research. Regardless, this showed evidence of Lucy’s TPACK, in that she saw the particular affordance of YouTube in allowing students to find instruction tailored to their personal inspiration. Lucy’s mixture of teacher directed use of a video to introduce a topic, followed by encouraging students to investigate using the YouTube platform was the sole example in this study, but showed a nuanced and varied pedagogical understanding of the uses of the technology to teach this particular topic. Following the lesson, Lucy reflected:

> That was a really good lesson. Just by the fact that looking around the room every single student was engaged and that doesn't always happen. So that's when you know you've hit on something good, when they're all engaged in the task. (I2)

6.4.4.3 Helen and Year 8 digestion

In the nine classroom observations, only one participant, the experienced Science teacher Helen, set a video for students to watch on their own devices. Helen asked the students to watch the ClickView video *Food and Digestion* on their own screen while completing a worksheet that she had sourced from the ClickView platform. While she admitted having never used this method of teaching before and telling me she only tried it because "I knew you were coming in" (I2; see Table 12), she was pleased with the amount of flexibility it gave her, and so said she would try it again, showing the development of new TPACK.

Helen reported that the students watching videos on their own devices with the ability to pause individually "allowed me to go around to do the individual lung capacity thing and I could get two things done in that lesson, which means that when we get to the respiratory system I've got that data ready" (I2). Helen measured each student's lung capacity using a spirometer, explaining the device and gathering the data for a future lesson. In this way Helen gained the key affordance of a flipped classroom, namely to gain time to meaningfully interact with students (LeCornu, 2018), while avoiding the common pitfall of students not previewing the video which she had found in previous attempts at flipped learning (I2).

Helen also reflected that had she used the online interactive video capability, the four or five students who forgot their laptop or failed to have it charged would not have been able to engage in the learning. As it was, Helen was able to group two or three students around one laptop while giving each a worksheet. Helen suggested that she would use this method of showing videos again, rather than her usual practice of "presenting it on the white board" (I1), demonstrating the process of reflection by which Shulman (1987) suggests new knowledge is developed. In this case, Helen had developed new understanding of the affordances of video to allow her to teach particular content more efficiently, an example of TPACK development.

An interesting feature of this new knowledge was that while Helen was willing to engage this pedagogical approach in her all girls science class, the follow up questionnaire a year later asked how the approach was working. Helen replied "this year I have Year 8 boys with 8 out of 24 on individual learning programs, which unfortunately makes it so any activity needs to be short and sharp" (personal communication, 11/9/19). In order to maintain classroom order in this new class, she limited activities to ten minutes or less. The contextual factor of the specific students in her class and her knowledge of those learners changed her reasoning as to the appropriate use of videos, showing again that TPACK is not context-independent, but is applied to particular content and particular learners (Rosenberg & Koehler, 2015b). In this later class, Helen had returned to the maxim most of the teachers held to that videos were usually best shown on projectors.

6.4.5 PCK - discussion

A central premise in PCK/TPACK literature is that pedagogical knowledge is not enacted in isolation, but applied to, and transformed by, the teaching of particular content. The data in this section reveals that this is true when teachers select and use instructional videos. Three themes emerged that reveal the importance of PCK in this study: (1) that videos may be seen as more useful to teach particular topics and domains; (2) that teachers draw on PCK when contextualising video content to their particular learners; and (3) that teachers with more experience tended to enact and explain more nuanced and purposeful integration of instructional videos into learning sequences than their less experienced colleagues. Throughout this section the sliding nature of TPACK (Cox, 2008) was revealed and that while TK was foregrounded in some selection and use, the technology was more often transparent.

Subject matter clearly affected teacher perceptions as to the usefulness of instructional videos with most videos in the sample depicting difficult to demonstrate scientific phenomena or human emotion. In particular, the science teachers (and Religious Education teacher Margaret when introducing a scientific phenomenon) saw an affordance of instructional videos in making visual those topics that were dangerous or impractical to demonstrate in classrooms. History teachers (Dennis and Melissa) expressed that footage of past eyewitnesses and events portrayed a human emotion lacking in other materials. In addition, the one Art teacher (Lucy) expressed that videos were particularly useful in showing the procedural motor tasks of artistic techniques to individual students. Conversely, videos were used least often in English classes. This finding supports a central premise of TPACK, that is that technologies are not useful in and of themselves, but are useful only when they facilitate the teaching of particular topics (Mishra & Koehler, 2006). While the systematic review (Chapter 3) shows that the use of instructional videos in STEM subjects has been well studied, there is a lack of research into the role of such videos in domains like History. The views of the History teachers in this study suggest there is scope to investigate this further.

Very few of the videos used by teachers were made specifically for their courses, and as such, the teachers were required to contextualise the content in order to make the representations “fit to be taught” (Shulman, 1987, p. 16) to their students. This drew on knowledge of the content, the learning goal, and the potential misconceptions of the class - in short, PCK. Using their PCK, the teachers drew the attention of students to some elements of the videos, and interpreted others. For example, Margaret paused her videos in order to define particular words with domain specific meanings, Troy paused his videos to convert imperial to metric measurements, and Dennis interrupted his videos to point out material linked to that lesson's overarching question. For the teachers with less developed PCK, or who were not aware of how the content of the video interacted with their course, this process of contextualisation was difficult or impossible.

Interestingly, self-reported TK was not a predictor of effective or nuanced use of instructional videos. Indeed, data revealed in this section provides examples of experienced teachers enacting and explaining more nuanced and purposeful integration of instructional videos into learning sequences than their less experienced colleagues. One caveat to this finding is that none of the teachers in this study reported using particularly advanced technologies in their use of instructional videos. As such, there may have been less of a disadvantage for teachers with lower TK than there may be in a study focused on the integration of other video technologies such as AR, VR, or video annotation. It is likely that the technology required to show YouTube videos on projectors has begun to be considered transparent rather than emerging (Cox, 2008). Indeed, considering the frequent use of videos as a didactic direct instruction technique (see Table 12) when shown on a projector videos were rarely a transformative influence on teacher pedagogy.

6.5 Conclusion

This chapter outlined the various ways in which teacher knowledge affected the selection and use of instructional videos, and the source of that knowledge. It also revealed some of the search strategies teachers employ when selecting instructional videos, and their beliefs about effective design. Discussion and analysis of these practices resulted in seven conclusions, each of which is briefly summarised here. Each conclusion addresses the research question or sub questions.

RQ1 How do teachers select and use instructional videos?

SQ1 What is the role of teacher knowledge in this process?

SQ2 What is the role of context in this process?

6.5.1 Wisdom of practice - the dominant source of knowledge

Throughout the interviews and subsequent correspondence with participants, a concerted effort was made to interrogate the teachers as to the sources and forms of their knowledge about instructional videos to address SQ1. The knowledge teachers relied on overwhelmingly took the form of phronesis, or wisdom derived from practice. This was shown most clearly by the questionnaire responses taken a year after data collection (see the introduction to this chapter) in which every participant cited wisdom of practice as their key source of knowledge. Interestingly, while Phillips et al. (2017) suggest "phronesis seems to be a reasonable way to conceive of some of the knowledge that expert teachers draw on to inform their practice" (p. 2426) this study shows that phronesis was also an important type of knowledge for novice teachers. Second year teachers Melissa and Carl (and indeed 27 year veteran Helen) reflected that they drew on their experiences as students, highlighting the reality that teachers do not enter the profession with no experience, but have usually spent at least 17 yeas in formal education and this constitutes an "apprenticeship of observation" (Lortie, 1975, p. 64). It should be noted, however, that an increase in experience did seem to correlate with a more purposeful and nuanced use of instructional videos, suggesting that this wisdom continues to develop throughout a teacher's career.

Shulman (1986) conceptualised wisdom of practice as being engaged when principles (derived from research) are in conflict. He explains that “we generally attribute wisdom to those who can transcend the limitations of particular principles or specific experiences when confronted by situations in which each of the alternative choices appears equally principled” (1986, p. 13). In contrast, there was little knowledge of the research base reported by the participants in this study, and as such the wisdom of practice became the starting point for decision making. Given the most nuanced, and arguably most effective, use of videos in this study were shown by experienced teachers with time to develop wisdom of practice (particularly Helen, Dennis, and Lucy), introducing young teachers to principles of instructional video research may reduce the time it takes to reach this refined level of effective practice.

Despite not being aware of the theoretical and empirical base of research into instructional videos and instead relying on wisdom of practice, the teachers in this study often demonstrated a tacit or intuitive understanding of CTML/CLT video design principles. For instance, teachers showed tacit knowledge of the *coherence* principle, the *video length reducing principle*, the *segmenting* principle and the *integrated practice activity* principle (see Section 3.5 for descriptions of each, and Section 6.2.5 for an analysis of teacher tacit knowledge of these principles). Indeed, to a large degree there was convergence between the knowledge derived from wisdom of practice and the literature.

Divergence between the practice of teachers and the findings in the literature emerged most starkly with regards to the presentation of videos in Section 6.4.3. While the literature review revealed most studies found a learning advantage for learner control, the teachers overwhelmingly opted to use a shared projector screen to show videos, retaining teacher control. Addressing SQ2 and the role of context, the teachers defended these practices based on

i. classroom management;

ii. minimising distractions; and

iii. the need to bridge or contextualise the content.

It is important to note that matters of classroom management, potential distractions, and clarifying content to learners have not yet been considered in the experimental research on instructional videos, despite being considerations for working teachers. While distractions could be considered examples of split attention or extraneous load, distractions external to the media have not been explicitly studied. SQ1 interrogates the role of teacher knowledge in the selection and use of instructional videos, and the following sections highlight the role of particular knowledge types in this process.

6.5.2 Knowledge of learners often motivates video selection and use

Instructional videos were perceived as popular with students, and the knowledge of this preference was a common motivator for teachers to incorporate a video into a class. Teachers cited student disengagement as a barrier to learning, and, echoing the findings of Plass and Kaplan (2016) saw a benefit of videos in building interest, therefore motivating cognition. The literature base dealing with attributed affect with regards to instructional videos is scarce, and there is a need to investigate this phenomenon.

While the preference of students for video and the belief that they motivated students was revealed in Section 6.1.1 as a motivator for the decision to search for a video, Section 6.1.2 highlighted the selection from amongst those available resources was more often framed by knowledge of learners' prior learning and culture. Teachers used their knowledge of their students' prior learning when selecting videos, rejecting those that used language that was beyond student comprehension.

In terms of teenage culture, the teachers in this study were particularly aware that if a video were considered "corny" (Louise, I2; Troy, I2; Melissa, I2) students would disengage. Conversely, videos that drew on popular culture or that were cool might help students "lock in" (Carl, I2). What was considered cool or corny changed with student age, as evidenced by Troy's declaration that Bill Nye was acceptable for Year 7 but that Year 9 students found him "ridiculous" (I2). School or class culture also impacted on this perception, hence the differing views of Religious Education resources featuring priests at the two schools (Section 6.1.2). This finding supports a central premise of the ICALM framework, namely that attributed mood is intimately connected to cognitive processing (Plass & Kaplan, 2016). This is an addition to Shulman's PR&A model, which did not describe the role of student culture in selecting curriculum materials, but also to the experimental approaches adopted in CLT/CTML research, which could consider further the role of affect when measuring the relative effectiveness of video designs.

6.5.3 Video selection is bounded by knowledge of a curricular hierarchy

While all teachers expressed a certain level of autonomy, in that they were left to choose their own videos, addressing SQ1 Section 6.2.1 revealed the topics they were required to teach were determined by their knowledge of the mandated curriculum, as set by the VCAA. This finding, that teacher actions are motivated by the need to deliver a prescribed curriculum under time pressure rather than in complete freedom, is not unexpected, but is an important consideration when conceptualising teacher knowledge. Shulman (1986) argues that teacher knowledge "guarantees only freedom" but knowledge of the mandated curriculum arguably does the opposite.

Section 6.2.1 also revealed that videos were also seen as subordinate to prescribed textbooks, when such books were adopted. Teachers chose videos that either enhanced content that was in the textbook or addressed content in the mandated curriculum that was not covered in the textbook. This revealed knowledge of a clear curricular hierarchy in which videos were subordinate to textbooks, and both were subordinate to the mandated curriculum.

6.5.4 Subject domain affects video use

Mishra and Koehler (2006) pointed out that "any given technology is not necessarily appropriate for every topic" (p. 1040) and that was upheld in this study. Sections 6.4.2 and 6.4.4 revealed that of the videos used by teachers, the majority were to present either abstract or hard to visualise Science topics such as tectonic plate movements, or content that relied on conveying human emotions, such as survivor testimony. There was a clear tendency towards using videos to convey the kind of content that direct instruction or text may struggle to, or phenomena deemed impractical to replicate in the classroom. This supports prior literature (see Section 3.1.4) finding that instructional videos are particularly good at conveying real life phenomena that are difficult to replicate in classrooms. Very few videos were used to teach English in this study, indeed experienced teacher Margaret did not report using a single instructional video in her English class, while using two to teach declarative scientific and structural content in her Religious Education classes (V43, V45). Addressing SQ1, the reasoning of teachers, particularly Helen, Troy, Dennis, and Melissa, suggests an understanding of the particular affordances of video, a kind of knowledge that could be considered TCK. This kind of reasoning and the divergence in reasons videos are used to teach various subjects highlights the danger of applying a "one size fits all" (Kizilcec et al., 2015, p. 724) approach to instructional video design and use as can be inferred from the CTML literature (see Section 3.5). While learning STEM topics through instructional videos has been studied extensively in the experimental literature (see Section 3.5 and Appendix B), there is a lack of studies investigating the role of video in portraying human emotion in the study of humanities subjects as was demonstrated by Melissa and Dennis. Such research may reveal previously unexamined affordances of instructional videos.

6.5.5 Low CK increases reliance on videos

Carl, Louise, Troy, and Alison all declared that they were more likely to use a video to help teach a class in a topic in which their CK was lower. In Section 6.3.1 Alison described an example of this in which she used a video to teach her class a topic about which she knew very little, hoping the video (V2) would also act as a source of information to her. While it makes sense that teachers operating under time pressures, as these teachers reported, may seek aids to teach content with which they are less confident, the use of videos from an unregulated, user-generated platform like YouTube raises concerns that are more fully dealt with in the next chapter. Certainly, the use of videos to augment teacher knowledge suggests Shulman's (1986) ideal that teachers would have content knowledge "at least equal" (p. 9) to those working in the field is not the reality in all cases. While the first sub-question for this study asks about the role of teacher knowledge in the selection and use of instructional videos, this finding is an example of the impact of a lack of knowledge.

6.5.6 Curricular search knowledge?

While teachers regularly used an uncritical search and scroll technique (Section 6.2.3) to search for new instructional videos, several deliberate search techniques emerged. Shulman included the knowledge to determine whether curricular materials are “fit to be taught” (p. 16) in his conception of curricular knowledge. However, the exponentially growing catalogue of materials on platforms like YouTube suggest these search strategies may constitute an important element of curricular knowledge previously unacknowledged in either Shulman’s framework or the TPACK literature – a curricular search knowledge. This is a new kind of knowledge influencing the ways in which teachers select instructional videos.

Showing again the challenge of compartmentalising teacher knowledge types, this search strategy component of curricular knowledge relies on other knowledge types. The actual use of search mechanisms like the YouTube search function could be considered a type of technical knowledge so could be considered a type of *technological curricular knowledge*, but this would perhaps unhelpfully add to the parsing of teacher knowledge types, and create even more fuzzy boundaries (Graham, 2011). This is because mechanical use of search functions is not enough, and a search repertoire ideally includes a knowledge of effective design; content knowledge robust enough to fact-check the video; and knowledge of the particular students in order to determine the cultural appropriateness of the content. This chapter has found that when these are not satisfied, teacher selection and use of instructional videos can be more rushed and arguably less effective.

While the nomenclature remains unclear, this study has found that search strategies are underdeveloped in some teachers. Apart from Melissa and Dennis, the teachers in this study reported searching for videos on YouTube using what could be termed a search and scroll technique, in that they entered generic search terms and then scrolled through the videos returned by YouTube. None of the teachers reported using any of the advanced search features, such as Boolean functions or filters, to refine their search. Therefore, critical search methods such as those outlined by Kuhlthau et al. (2008) are arguably becoming more important for teachers. Instead, teacher practices relied on the internal logic of the YouTube search algorithm to deliver appropriate content which has been found to be problematic (Rieder et al., 2018). This human software entanglement (Edwards, 2015) is explored in the next chapter.

6.5.7 Knowledge both empowers and bounds practice

Throughout this chapter, knowledge of learners, content knowledge, and PCK derived from wisdom of practice emerged as particularly empowering for teachers, providing them the necessary tools to effectively select and plan with instructional videos. However, the research questions address the role of knowledge, and multiple examples of knowledge providing boundaries to teacher action, rather than “guaranteeing freedom” (Shulman, 1986, p. 13) have emerged. Knowledge of mandated curriculum bounded video subject matter; knowledge of student culture prevented teachers from using corny videos; and knowledge of the school culture prevented Helen from using a potentially controversial video (Section 6.4.4.3). This study suggests that teacher knowledge provides the freedom to reason pedagogically, but only within particular boundaries. This is an important contribution to the way in which teacher knowledge is conceptualised.

In answering the main research question, this chapter has primarily addressed the first sub-question by interrogating not only the practical matters of how and when teachers use instructional videos, but also the role that their knowledge plays in this process. Importantly, the effects that varying levels of knowledge have on the effectiveness of teacher practice have been examined. This chapter has identified that while working teachers have a tacit understanding of cognitive processing principles, they often make decisions that are at odds with experimental findings and that the contextual factors leading to this divergence deserve attention. Further, while there are clear trends among the teachers in this study, the selection and use of instructional videos is necessarily context-bound in terms of subject matter, students, and school systems. These factors are examined in greater detail, along with the influence of algorithmically driven platforms, in the next chapter.

Chapter 7: The influence of context

The previous chapter demonstrated that teacher knowledge shapes the selection and use of instructional videos by teachers in mainstream secondary schools. However, teacher knowledge is necessarily enacted in specific contexts and an answer to the main research question would be incomplete without a discussion of the contextual factors, known and unknown, that mediate the practical application of teacher knowledge. This is because teacher knowledge and reasoning do not happen in a vacuum, but exist in a dialogical and socially mediated relationship with the contexts in which teachers work (Phillips et al., 2016). This chapter focuses on the second sub-question, discussing the factors affecting teacher use of instructional videos that exist beyond teacher knowledge. These factors include time pressures imposed by school systems, the dominance of the YouTube platform and its complex algorithm, the access to technology, and teacher labour practices.

Throughout his work, Shulman (1986, 1987, 1991) put great importance on the role of context in mediating the ways in which teaches enact knowledge. For example, Shulman (1986) argues that in real classrooms “individual principles are fated to clash on particular occasions” (p. 13) and suggests it is in such moments that strategic knowledge (Section 2.3.3) assists teachers in applying their knowledge to these particular contexts. Shulman (1987) also includes knowledge of educational contexts in his list of knowledge types (Section 2.1). What is less developed in his work is the influence these contextual factors have in bounding or motivating the enaction of teacher knowledge and it is this influence of context on teacher practices, rather than their knowledge of the contexts, that is explored here. In short, how do contexts (known and unknown) affect the ways teachers enact their knowledge when selecting and using instructional videos? These contexts will be explored using the contextual framework proposed by Porras-

Hernández and Salinas-Amescua (2013) and expanded upon by Rosenberg and Koehler (2015a). This framework differentiates between the actors (teachers and students) and the scope of context (micro, meso, and macro).

Rosenberg and Koehler (2015a) identify that context is both "*that which surrounds* the object of study… [and] that which is *woven together* with the object of study" (p. 440, emphasis in original). For instance, while school systems and timetables surround the work of teachers, they are also woven together with them, influencing the decisions teachers make. As was outlined in Chapter 4, micro factors are those that occur within the learning environment, such as available technologies, subject matter, and room design (Section 7.1). Meso factors include functions of school organisation within which the learning environment exists such as the availability of support staff, timetable considerations, school culture, and the range of school policies (Section 7.2). Macro factors are comprised of those influences that are dictated by society or government, such as state school curricular, child protection policies, state technology restrictions, and national testing regimes (Section 7.3). To demonstrate a close alignment with their framework, each section is preceded by a short excerpt from Porras-Hernández and Salinas-Amescua (2013) outlining the contextual level.

This thesis introduces online curriculum platforms, particularly those run by algorithms like YouTube, as a macro-contextual factor. While Shulman (1986) lists knowledge of educational contexts as part of the knowledge base for teaching and most of the contextual factors were known to teachers, this chapter will explore the reality that context affects teacher enactment of knowledge whether known or not.

7.1 Micro context

> The micro level context is concerned with in-class conditions for learning. These conditions may involve available resources for learning activities, norms, and policies, as well as the expectations, beliefs, preferences, and goals of teachers and students as they interact. (Porras-Hernández & Salinas-Amescua, 2013, p. 230)

Much of what occurs at the micro level, including the interactions of teachers and students, expectations, beliefs, preferences, and goals of teachers has been discussed in the previous chapter and can be explained through reference to teacher knowledge. Indeed, it is in this micro context that teachers enact knowledge and develop new knowledge through the wisdom of practice. Of the factors listed by Porras-Hernández and Salinas-Amescua (2013) only available resources, policies, and classroom management have not been fully discussed in Chapter 6, and of these participants only reported that classroom management was an important consideration in shaping their teacher reasoning or action. A brief discussion of them follows here.

7.1.1 Access to technology

Ertmer et al. (2012) suggest that first order barriers to effective technology integration, meaning the availability of technology, have been reduced or eliminated, to the point that access to the internet and collaborative software is “almost a non-issue” (p. 424). While not true in all parts of the world (Lavery et al., 2018; Tarus et al., 2015), this was true for the participants in this study in terms of high quality to internet connections and technologies to display videos. Not only was every student required to have an internet-enabled device in every class, but the rooms were all equipped with projectors and high-quality sound systems. At Station College, internet speeds and reliability had improved due to a recent upgrade in the network resulting in 95% uptime of internet connection according to the ICT Systems Manager. Being a relatively new school build in a growth area, Wayfarer also had access to excellent internet connectivity and the teachers reported that it was very reliable, with Alison saying “we’re very lucky” (I1). Because of this, most teachers reported internet connection having no active impact on their pedagogical decision making. Only Margaret at Station College expressed scepticism as to the connection speed and cited this as a reason she chose to use the projector instead of allowing students to stream videos individually. More commonly, the belief that the internet would work facilitated and empowered teachers to plan with confidence. This was typified by Louise at Wayfarer, who was surprised to find out after our class observation that YouTube had rectified a worldwide service outage mere minutes before her class began. When asked if she had a contingency plan for that she replied “no, not really” (O). This supported her earlier claim that “a couple of years ago I would have said yes” to the internet speed affecting her planning, “but I’ve not had any problems for the last couple of years” (I1).

While minor technical difficulties were observed in Margaret, Troy, Carl, Melissa, and Helen’s classes, each teacher was able to rectify these issues very quickly and none negatively affected the classes. The most disruptive technological hitch was observed during Margaret’s class, when the projector in her regular classroom failed to display. But she found it easy to move her class to another room, swapping places with a colleague who was not using his projector at the time. At Station, a change of firewall settings at the central Catholic Education Office, Melbourne had caused some YouTube videos not to be available, and Margaret had found this frustrating, but the school was rectifying this at the time data collection was taking place. In short, teachers planned with an assumption that technology would work, and the data revealed that the availability and reliability of this technology meant teachers were able to plan lessons using videos with confidence.

The experiences of teachers in this study suggested that teaching using student devices was more likely to encounter difficulties than when using the projector. Teachers expected that it was unlikely that all student devices would be available, charged, and accompanied by appropriate accessories such as headphones. This factor was cited by Carl and Alison as a reason to default to using the projector to show videos (see Section 6.2). During Helen's class, the only one in which students were asked to watch a video on their own device, she was observed troubleshooting a range of technical issues. These included isolating a student without headphones at the back of the room, providing a spare charger to a student without one, and grouping students together around one laptop when two students failed to bring their own. While the data was limited to only this class, it is possible that if teachers used student devices more often, then student skill, maintenance, and reliable bringing of devices to class may be a micro-contextual factor influencing teacher selection and use of instructional videos. In the conclusion of Chapter 6 it was posited that TK was backgrounded in this study because of the simplicity of the technology employed. The micro-contextual factor of technology availability and reliability may not act as a barrier for the same reason. It is fair to presume that in schools in which more student-centred video practices were prevalent, or in which internet or technology was not reliable, different practices may be observed.

7.1.2 Impact of Policies

Micro-contextual factors include the school policies that directly affect classroom practice. For example, a school discipline policy, which outlines how teachers deal with behavioural issues arising in class may act as a motivator or constraint on teacher interactions with students. Therefore, while policies are *created* in the mesosphere, they are often *enacted* at a micro level. The teachers in this study spoke of policies concerning the selection and use of instructional videos in vague terms, with most admitting they had never read them. When asked about the policies, six of the participants (Margaret, Dennis, Carl, Alison, Louise, and Lucy) stated knowing there was a policy ban on showing films with adult ratings, but this related to feature films rather than instructional videos. Veteran teacher Margaret recalled "I think we had something a couple of years ago that what you showed had to have some educational purpose to it… I haven't looked at it for a long time" (I1). Lucy also suggested a ban on time-wasting films, saying "you're not really supposed to show Shrek, there's no fillers" (I1) which has been identified as a problem in past studies (Hobbs, 2006) but was not seen in this study. Dennis, who was deputy principal of Station College in charge of learning explained that their policy only included restrictions on adult-rated films, then admitted that "I don't know if a general staff member would [be able to locate the policy] and that's actually a wider issue" (I1). Whether or not teachers were aware of this policy, none of the participants reported knowledge of any restrictions on the use of instructional videos.

In addition to the lack of clear policy on the types of instructional videos shown to students, neither school had limitations on teacher or student access to YouTube. At Wayfarer, this was a policy (or more accurately, lack of software restriction) that Lucy, as a member of the school's e-learning committee, had championed. This meant teachers were free to allow students to watch videos on their own devices, and while this was a rare practice in the data, it meant that teachers could make their decisions without this contextual barrier. The same study completed in schools in which restrictions were in place, such as Queensland Government schools whose students cannot access YouTube during school hours (Department of Education and Training Queensland, 2017) may produce different data. In short, teachers in this study largely felt free to choose their own instructional videos, from whatever platform they chose, without restriction from policy. Regardless, only Dennis suggested he had read the policy recently and as such, policies cannot be considered to have exerted any meaningful contextual influence on the practices of teachers. While there is growing concern that there is a lack of "sufficient debate" (Arantes, 2020, p. 2) about the role of commercially driven data platforms such as YouTube, and that schools might be well served by clear policies regarding their use, discussion of this is beyond the scope of this thesis.

7.1.3 Maintaining classroom control – another reason for projectors

In Section 6.5.3, the practices of bridging and contextualising were revealed as reasons teachers chose to show instructional videos on class projectors, rather than allow students to view them on individual devices. In short, teachers saw part of their role as sense-making and translating the content of the videos based on live feedback. This section explains a further reason for this overwhelming preference for the use of projectors (51 of 58 videos), namely the desire for classroom control. A knowledge of the classroom micro-context in which teachers act informed these choices. In line with findings of prior research (Loughran et al., 2016; Melnick & Meister, 2008; Philipp & Kunter, 2013), this focus on classroom control was more prevalent in the younger teachers than those with extensive experience.

Student distraction was an important reason cited by the younger teachers for avoiding learner control over playback. Carl imagined that if students watched on their own devices the resulting noise would be distracting, saying “no, definitely not on devices because it doesn't quite work when they're pressing them at different time with the noise” (I1). Melissa, Louise, Dennis, and Helen had solved this dilemma by asking students to use headphones in class, but still reported a preference for whole class presentation. Acknowledging the potential benefits of learner control, Alison wrestled with both the technical and classroom management implications of ceding control.

> **Alison**: *I haven't figured out how to monitor them using their headphones. I could use subtitles but the kids that can't read what am I going to do with them? So I haven't really figured it out yet.*
>
> **Researcher**: *So, it would be too distracting if all of the speakers were on at the same time?*
>
> **Alison**: *yes*
>
> **Researcher**: *So, not so much behaviour management as environment management?*
>
> **Alison**: *A little bit of behaviour management. A bit of both because if they did have the headphones in I'd question whether they're actually listening to music as opposed to doing what they're supposed to be doing. (I1)*

In her second interview, Alison was even more direct about her desire to keep control because, as she said “at the moment I'd rather we watch it together just because I don't trust them [the students]” (I2). In her first year, Alison reported that classroom management was her key focus and influenced many of her decisions, saying “I think it's almost ingrained in what I try and do, because if I don't have control of them, for me they're there to learn primarily so I just need to figure out the best way for that to happen" (I2).

Further showing the focus on classroom management in the reasoning of the least experienced teachers, Melissa highlighted the frustration that learner control could cause to the timing of a class based on her limited wisdom of practice:

> I tried it on their devices last time, but it meant that the slower kids would take about 25 minutes to get through it and the other kids would be finished within 11 minutes. Then it's like well you can start the next activity but you'll then get to another point where you are at the end of the lesson and there's 25 minutes where half of them are finished and half of them haven't. So this one was easier because we had the steps to do it as a group. (I2)

Science teacher Louise, with 16 years' experience, also saw a classroom management advantage of showing instructional videos in difficult classes. While in her Year 7 Mathematics class, Louise allowed her students to work independently through the Maths Pathways program, in her Year 9 Science class with more behavioural challenges, her decision was different. Discussing the reasoning for using the projector when showing Jeremy LeCornu's video *What is Diffusion?* (V38) she explained:

> This class is an interesting one. I could have explained diffusion the way this guy did it up on the board and that sort of thing. But from a classroom management perspective it's nice to be able to have the ability to walk around and make sure they are all staying on task, especially the way that our room is set up. You can kind of hide in the back of the room. It's a science lab, so yeah it kind of is really helpful for

> me to make sure I'm walking around and they are doing the questions and working, concentrating at the same time as listening. So it allows me to duplicate me. (I1)

Louise drew on her knowledge of this particular "interesting" class context when considering which of the pedagogical affordances of instructional videos to exploit. This example lends support to Shulman's (1986) assertion that knowledge empowers teachers to make decisions, leading to "grounded unpredictability" (p. 11), in that Louise defended two seemingly contradictory pedagogical conclusions, based on her knowledge of the micro context of each class.

It is interesting to note that in the systematic literature review conducted for this thesis (see Section 3.5) the vast majority of studies on video design were performed under experimental conditions with one student at a time watching an individual screen protected from any distractions. Amy, Carl, Louise, and Melissa's focus on classroom distractions and organisation puts in doubt whether such experimental conditions are analogous with genuine secondary school teaching contexts in which decisions about video playback are mediated through a lens of classroom management. This lens was of particular importance to the less experienced teachers, with Louise the only experienced teacher citing this reasoning. This skewing of classroom management as a consideration is consistent with the work of Melnick and Meister (2008) who found that concerns about classroom management decrease over the span of a career, particularly in the first three years. This suggests that the knowledge used by teachers when planning with instructional videos is not only context-bound, but may be influenced by the career stage of the teacher.

Finally, at a very practical level, some participants cited the fact that when a video is shown to the whole class, the teacher can be sure that all students have watched it. This was in contrast to teachers' consistent estimations of around 50% of students who watch videos at home when they are set (Margaret I2; Helen, I2; Louise, I1; Lucy, I1; Troy, I1). It was interesting to note that this was a consistent estimation across schools and subject domains. While there are functions in ClickView, *EdRolo*, and YouTube embedding platforms that allow teachers to track whether students have watched the video, none of the participants had used them. When Helen did use an alternative method of tracking student watching in class, via a worksheet students had to upload to the school intranet, she found "less than half" (I2) had completed it. In response she took the worksheet down off the intranet and showed the video at the start of the next lesson using the projector.

Showing the difficulty of parsing teacher knowledge (Mishra & Koehler, 2006), Troy summarised all three reasons for using a projector rather than independent devices in his description of how he showed curated videos in his Science classes:

> When it is projected I can ensure that all of them have watched it and all of them are paying attention to it. If they're watching it on their own devices it's very easy for them to deviate and to go on to other things through YouTube and get a bit distracted, and then also they need their own earphones as well and that's not always the case. And then at the end of showing it to the whole class then we can then discuss it as a whole class as well because we've all just watched at the same time and I can pause it at certain times too and dissect certain pieces.

In this example, Troy's TK was foregrounded, evident in his comment about the distracting nature of the YouTube platform and the whole class viewing afforded by the projector. He also drew on his knowledge of learners in his estimation about their bringing headphones. This confluence of knowledge types was combined to create TPK in that Troy reasoned that in general a projector was more effective than an individual device for showing videos.

While it should be remembered that this data is drawn from a limited sample of nine teachers, and that it may not hold true for the wider population, this study suggests that contrary to the consensus in the experimental video literature (Section 3.5), teachers often perceive that showing videos on communal projectors leads to better pedagogical outcomes than allowing students to watch on their own devices. None of the teachers reported being aware of the literature base on learner control, but instead relied on their wisdom of practice (see Section 2.2.4 and 6.5.1), particularly concerning the likelihood of distraction and the ability for the teacher to monitor student understanding.

The micro context is the immediate environment in which teachers enact their knowledge, “the most proximal context for learning and development” (Rosenberg & Koehler, 2015a, p. 448). As such, much of what might influence teacher selection and use of instructional videos has been discussed in Chapter 6. For example, the reactions of students to types of videos (Sections 6.1.1 & 6.1.2), the practicalities of classrooms including student absence (Sections 6.1.4 & 6.1.5), and the interactions of teachers and students (Sections 6.4.3 & 6.4.4), all belong to the micro context (Porras-Hernández & Salinas-Amescua, 2013). Two of the microcontextual factors discussed in this section, availability of technology and policy, were not seen as major influences on teacher practice, apart from the reality that teachers felt unencumbered by either. On the other hand, classroom dynamics and the desire to maintain classroom control did influence teacher actions, particularly with regard to the choice of technologies to show instructional videos. Otherwise, for this group of teachers, at the most proximal microcontextual level, teacher selection and use of instructional videos was explained through a description of teacher knowledge (knowledge of students, Curricular knowledge, CK & PCK). More influential, however, were the meso and macro factors of context.

7.2 Meso context

The meso level of context incorporates "the social, cultural, political, organizational, and economic conditions established in the local community and the educational institution" (Porras-Hernández & Salinas-Amescua, 2013, p. 228). Rosenberg and Koehler (2015a) add that:

> Meso factors are proximal to teachers but are not the contexts in which teaching and learning usually takes place; instead, meso factors influence teachers through the ways in which the custom and norms of communities and institutions shape teachers' micro contexts. (p. 449)

Three key themes affecting teacher selection and use of instructional videos emerged in the data at the meso level. First, the labour required by the organisational structures of both schools meant that teachers felt time-poor, and rushed in their selection and planning with videos (Section 7.2.1). A second meso-factor was the perception amongst teachers that choosing instructional videos was largely 'supplementary' to normal collective curriculum planning, which involved text book and topic selection, and the writing of assessment tasks (Section 7.2.2). Because the selection of video resources was usually an isolated practice, teachers felt empowered to make their own individual decisions, but regularly replicated labour of others and failed to learn from shared practices. Finally, an isolated but particularly interesting account of Helen weighing her perceptions of the school culture in which she taught against her own PCK is explored (Section 7.3.3).

7.2.1 Time constraints and pedagogical triage

Because of his focus on teacher knowledge, Shulman's (1987) framework (Section 2.1) did not explicitly account for the demands of teacher time as a factor determining pedagogical action or inaction. But the labour of teaching involves juggling, and at times selecting not to complete some of the myriad complex tasks teachers are expected to complete. In order to deal with the labour demands of teaching, Philipp and Kunter (2013) found in a study of German secondary teachers that teachers, particularly at the beginning and end of their careers, engage in a range of selection, optimisation, and compensation practices. Selection of tasks refers to channelling efforts into tasks that are considered important or interesting, including at times avoiding tasks that are considered less important or too draining on resources in what is called "loss-based selection" (Philipp & Kunter, 2013, p. 3). Optimisation refers to the development of skills, such as time management and efficiencies, that help a teacher deal with their demands. Finally, compensation describes using alternative resources such as colleagues or "changes in allocation of one's efforts" (p. 3).

Supporting these findings, in a wide ranging study of beginning and experienced US teachers, Melnick and Meister (2008) found that while some concerns of teaching such as classroom management and parental communications reduced over the span of a career, time management remained an important cause of stress. In Australia, Timms et al. (2007) found that "teachers… have reached a level of workload that is unsustainable and which constitutes a serious risk to their mental and physical health" (p. 569). McCallum and Price (2010) also concluded that the primary frustration of beginning teachers was the feeling of being time-poor.

The participants in this study universally cited perceived lack of time as a motivator either for, or against, certain practices with videos, lending support to the findings of the literature on teacher time concerns. Indeed, a common complaint was that teachers aspired to create videos, activities, or to more carefully search for resources, but that they felt constrained by a lack of time. This shows that while teachers may possess the knowledge base and inclination to act in a certain way, they feel unable to reify this, a finding consistent with earlier research on technology enactment (Berg et al., 1998). In such circumstances, teacher knowledge was of secondary importance to teacher labour capacity.

When investigating notions of workload and time pressures, Philipp and Kunter (2013) argue that consideration needs to be taken both of objective demands, in terms of work hours and tasks and subjective experience in terms of "perceived workload" (p. 2). This recognises that both the actual demands of teaching and the interpretation or internal rendering of those demands contribute to teacher perception of available time. While this reality is interesting, it is the perception of teacher time that affects the triaging of tasks by an individual teacher, so for the sake of this study, self-reports of time-poverty or demands will be taken at face-value. What follows are the ways in which the perception of time pressure affected the practice of teachers, beyond that which has already been discussed in the previous Chapter.

7.2.1.1 Video enhancement

Several of the participants reported aspirations to create enhanced or interactive instructional videos but had not managed to due to a perception of time-poverty. Such aspirations included both the creation of traditional worksheets and the use of video hosting platforms like ClickView and TedEd to insert custom questions and activities within videos the teacher had selected. As was discussed in Section 3.5.6.1, completing activities during video watching has been found to lead to improved student learning outcomes (Delen et al., 2014; Szpunar et al., 2014; Vural, 2013).

Despite these aspirations, interactive functions were rarely used and while Melissa and Lucy reported having used the ClickView feature once each, neither could remember for what video they had used it. Teachers largely blamed their lack of use on the time required to set up such resources. For example, Helen reported that she spent almost two hours trying to create an interactive video, before deciding to simply print out a worksheet that was provided on the ClickView platform. Subsequently she said she wouldn't try it again both because the worksheet worked well and because of the time cost (I2). Helen reported that the use of a worksheet, rather than interactive features, acted as a kind of technical fallback in the classrooms. When a student laptop malfunctioned or ran out of battery, which happened three times during the observation class, the student could continue working on their worksheet while watching the video on another student's device.

This approach of using a physical worksheet to supplement a digital video resource was common with six other participants reporting having used it. Dennis explained the tension in spending time exploring new technology to improve student learning when discussing the segmenting feature in the ClickView platform that he would like to use:

> [segmenting] is something you actually can do in Click View but it's not something that I've gone to the lengths to do yet. It's kind of on my list of, okay when I have enough time I'll go back in and work out how to do that particular one as well. (I1)

When pushed to consider what is was that was stopping him from embracing the affordances of ClickView, he answered:

> Everything else. The fact that there's there are so many different things that you can do and there's a limited amount of time, not that there's little time, but you've got to prioritize exactly what is going to be more important. So, for myself I'd say I prioritize getting the students doing trial tasks and spending the time and giving them the feedback on that. Hattie's research will tell you feedback is just about number one I think it is number two in its overall effect sizes that quality feedback is what improves student skills and understanding more than anything else. So, if it comes to balancing which thing do I spend my time on? It's going to be creating another task and spending the time giving students feedback on that rather than adding another bell and whistle which actually adds to but is not essential. (I1)

Dennis had decided based on research, Hattie's (2008) visible learning, that his limited time was better spent providing feedback than augmenting the videos he showed. It is an interesting side note that this is the only mention of specific research in the data collected for this study. Dennis had selected from among the tasks he considered could be valuable to his students, engaging in the one he predicted would be most effective. It is important to note, however, that Dennis considered the enhancements offered by the ClickView platform to be "bells and whistles" (I1) rather than essential aspects of video use. If Dennis were aware of the research on video enhancement (see Section 3.3), he may have selected differently. Dennis's example is evidence of the interaction between teacher knowledge and context. He knew what he would like to do for the students but felt he was constrained by the contextual factor of workload.

Even creating a worksheet was considered too time-consuming under the pressures of teacher labour for Carl, who claimed "this year I just don't have the time to create worksheets" (I2). For Troy, also, the habit of not previewing the videos shown in class meant that his activities were mostly discussion based rather than planned in advance. It is interesting to note that because Helen had used the ClickView platform to search for her videos, she was able to use a pre-created worksheet downloaded directly from the platform. She explained that “it means I've got less work to do I don't have to actually sit and watch the whole video and come up with a set of questions because that part has already been done for me” (I2). This compensatory practice (Philipp & Kunter, 2013) was not available to Carl or Troy who used YouTube exclusively, meaning that Carl saw the creation of resources as a task that fell solely to him, and one for which he could not find time.

This section shows that teachers recognised the value of active learning while using instructional videos, and knew of the technical capabilities of the platforms available to them. The use of these platforms was low not because of a lack of teacher knowledge, but because of the meso contextual factor of the perceived demands on teacher time.

7.2.1.2 Bespoke video creation

As discussed in the section on curricular knowledge (Section 6.3), Alison made the point that it was unrealistic that any video would perfectly match the curriculum goals “unless you made it yourself” (I2). Despite this, of the teachers in this study only Troy regularly created instructional videos for his students. He explained the process as time-consuming and requiring particular technical skills, often taking him a day to create a high-quality video (I2). At the time of being interviewed in 2018, Troy was at a peak of video production, publishing 12 videos on his channel, yet claimed not to have time to preview the YouTube videos he showed his classes. This suggests a selection of production over class preparation, and highlights the argument of Philipp and Kunter (2013) that teachers select tasks to focus on based not only on effectiveness (as Dennis had), but also on interest. Supporting this idea, Lousie had created some simple videos for students by recording herself while writing on a tablet in class, Khan style (see Section 3.2.3). She stopped doing so when the school purchased the Maths Pathway program that includes a series of explainer videos. She considered at that point that creating videos would be "reinventing the wheel" (I2). Given the amount of effort put into production, and the vision for their respective YouTube channels (Louise's was set to private while Troy monitored the worldwide use of his "religiously" (I2)) identity and interest may be key motivating factors in engaging in this kind of labour demanding practice, but these are beyond the scope of this thesis.

The other teachers in this study did not consider video production important enough to preference this labour over other tasks, citing time as the principal reason. Carl wanted to create videos but claimed "I haven't had the time" (I1). When pushed as to what was taking that time away, Carl replicated findings that early career teachers tend to preference the tasks closest to what they see as the core survival practices of teaching (Loughran et al., 2016; Philipp & Kunter, 2013). In particular, Carl stated "because I'm teaching everything for the first time this year I'm just trying to get my head around the curriculum and learn to design a curriculum" (I1). Similarly, Alison saw creating videos as a luxury of teaching, stating "if it was easy I would, if it didn't take long" (I1).

Lucy aspired to make a series of how to videos with her colleagues in the Art department to demonstrate art techniques that they spent so much time repeating. This plan to both empower student autonomy and improve efficiency was itself prevented by a perceived lack of time, as a year after suggesting this project was an important priority, she had not yet begun the process citing "time constraints" (personal communications, 6/10/19). The data in this study shows that, in the Australian mainstream context, teachers continue selecting between tasks of competing priorities throughout their career (Melnick & Meister, 2008), because they did not consider that they had enough time.

While time constraint was the most cited reason for not creating videos, it should be noted that other reasons were also cited. For instance, Melissa simply said “I just wouldn't want to listen to my voice” (I1) when recorded. Louise also cited a dislike for her own voice as the reason she restricted to private the few videos she created before the school purchased the Maths Pathway program. However, the most cited reason for not creating videos was the demand on teacher time as determined by the meso contextual factor of the school timetable and labour demands on teachers.

7.2.1.3 Time or knowledge

Shulman (1986, 1987) argues that improving teaching is dependent upon improving teacher knowledge. Great teachers, he observes, draw on a vast store of particular types of knowledge to make pedagogical decisions. But the experiences of the teachers in this study suggest that teachers often have knowledge about what to do but feel they do not have the time to enact what they see as best practice. This is not always a deficit in knowledge, but in time or time management skills. In short, given vastly more time to prepare, the teachers in this study claim that they would act in different ways concerning their use of videos. Some would create their own bespoke videos, improving specificity and coherence. Some would add interactive activities into the videos or create customised worksheets. Some would take the time to more carefully preview or fact check the videos they used. Perception of time poverty acts as what Joyce and Cartwright (2020) describe as a “derailer” (p. 1063), meaning a contextual factor that impedes the application of evidence-based practices. Of course, it is not possible to determine whether such a reduction in time pressure would in actuality change these practices (McCallum & Price, 2010). However, it is clear that at least some practices (such as Dennis's exploration of ClickView and Lucy's failure to create the videos she has planned) are curtailed by the feeling of being time-poor, an artefact of the meso-contextual factor of institutional labour demands on teachers (Timms et al., 2007).

7.2.2 Video selection as an individual process

The data suggests that amongst the nine participants, selection and use of instructional videos was largely an individual, rather than collaborative, labour. While seven of the participants claimed they shared videos with colleagues, and acted collaboratively in collating resources, only six of the 58 videos teachers reported using were sourced from or planned with colleagues. An example of the replication of labour this caused can be found in the practices of Louise and Troy. Both teachers taught Year 9 Science at Wayfarer at the two junior campuses, and both used videos (V36 & V54) to help teach the topic of Plate Tectonics. Despite both claiming they share videos with the rest of their teaching group using Microsoft Teams, they reported using two different videos to teach the same content. When this was posed to each of them, they said that "each teacher needs to find their own sometimes" (Louise, I2), and "we don't tend to share resources across campuses much" (Troy, I2). Lucy concurred with this view, saying that teachers at Wayfarer do share resources, but these are "more so PowerPoints" (I1) than videos. Troy explained that videos were more likely to be shared informally, "generally it's just face to face in passing" (I2). The exception to this was Troy's own videos, which he shared enthusiastically, and Louise reported using. At Station College, Helen agreed that sharing of resources was usually done on an ad hoc basis, and that due to running "flat chat" she had "probably forgotten to share" (I2) many of her videos. When videos were shared, they were seldom used. Indeed, Helen said that the day after using a video on digestion (V24), another teacher sent her a different one, which she ignored.

Of the six videos that were recommended by colleagues, only the two younger teachers at Wayfarer, Melissa and Alison, reported using videos that came recommended from their department heads. Troy managed to copy a series of *Bill Nye the Science Guy* videos (V56) from a colleague, which he kept on a USB drive but used independently of any specific pedagogical advice from this colleague. Of the videos used by teachers at Station, only Margaret reported using one shared by a colleague (V42) and that was because the colleague was "someone who has only come back to teaching RE after a very long time and is not 100 percent you know, so we keep in touch with what we do" (I2). Margaret went on to say that this colleague was relying on her as a "mentor" (I2) and that this sharing of the video was partly to check if it was fit to be used. This was the single example of genuinely shared practice (rather than simply e-mailing a link), so was an exception in the data.

Eisner (2002) suggests that in order to develop phronesis, "part of the answer is through deliberation with others" (p. 382), meaning purposeful shared interpretations of teaching practice. Apart from Margaret's example, such discussions and shared practice were lacking from the data, implying that the use of instructional videos may be an area in which deliberate shared reasoning should be encouraged. Such a change in the meso contextual culture of collaboration in these two schools could lead to improved practices, or at least a reduction in teacher labour. This is particularly true for younger teachers, for whom phronesis is in its infancy. Helen identified selecting videos as a "learned art" (personal communication, 11/9/2019) and suggested that younger teachers may benefit from watching videos selected by more experienced colleagues. While Alison and Melissa did report using three videos selected by their faculty leaders (V5, V46, & V49), it was still the case that most of their selection and planning was done in isolation.

Beyond simply sharing the resources they choose, Shulman (1987) argued that there is a need to record and share the "reasoning and actions of gifted teachers into cases" (p. 12) or at least recorded in local curriculum documentation. This resonates with the data in this study given the finding that experienced teachers tended to integrate videos in more purposeful and effective ways than novice teachers (see Chapter 6). Shulman (1987) decried the lack of formal documentation of new teacher comprehensions, lamenting the "aha of a moment that is never consolidated and made part of a new understanding or reconstituted repertoire" (p. 19). In a 1988 interview, Shulman reflected that "we educators leave almost no record of what we've done" (Brandt, 1988, p. 43). While some teachers (Lucy, Louise, Dennis, Helen, Margaret, and Melissa) in this study reported keeping records of the videos they used year on year, these were in private documents, rather than building a shared repertoire, as Shulman (1987) advocated. This suggests that the problem Shulman encountered in 1987 remains an issue in current practice. It is clear from the data in this study that, rather than sharing practices and reasoning, teachers had developed a culture of isolated labour with regard to the selection and use of instructional videos.

The contrast between the reported collaborative practice and the usual reality of teachers acting in silos is an important finding regarding teacher pedagogical action. This lack of collaboration in the use of videos was not due to teachers being protective of resources, as the teachers reported collaborating on non-video resources such as PowerPoint presentations and assessment tasks. Rather, this lack of collaboration was a product of a perception that instructional videos were an “add on” and therefore left to each teacher, perhaps akin to the particular personal representations and metaphors Shulman (1986) reports experienced teachers using on an almost ad hoc basis.

7.2.3 Perception of school culture

At Station College, Science teacher Helen was faced with a tension between her PCK and her perception of the conservative meso culture in which she was employed when deciding which video to select for her Year 8 Science class. Having chosen to use a video to introduce the digestive system, Helen found herself choosing between an episode of the BBC series *Don’t Die Young* (V22), which she had used at her former school, and a “ho-hum” (I2) program from ClickView (V24). Helen explained that she wanted to show the BBC program because her past students (at a different school) had found it engaging, pointing out some of the highlights of the show:

> It basically went out to young people, often in pubs and things like that, and did a *Don't Die Young* version of the digestive system. They got this woman who basically lived off coffee and chocolate and they made her eat a bowl of corn to see how long it took for it to emerge at the other end, and that's what's so funny about that series… as part of that series Dr Alice whatever-her-name-is likes to get a naked body and paint the system on them to show you where things sit. So if it's lungs she’ll paint lungs… and they're beautiful paintings done on somebody's body. (I2)

The presenter had credibility in Helen’s view yet spoke in language that resonated with students without trying to be “too cool”. This showed Helen’s sensitivity to the cultural preferences of her students (see Section 6.1.2). Despite this, Helen chose to use what she saw as the inferior ClickView video because “this school’s a little bit more circumspect and so I didn't use it” (I2). The fact that Helen considered the cultural mores of the school regarding nudity to override the affective preferences of her students shows that teachers do not always feel free to enact their PCK, a reality unacknowledged in Shulman’s work. While Shulman (1987) recognised that teachers work in “institutions with their hierarchies, their explicit and implicit systems of rules and roles” (p. 8), he also argued that:

> Knowledge guarantees only freedom, only the flexibility to judge, to weigh alternatives, to reason about both ends and means, and then act while reflecting upon one’s actions. Knowledge guarantees only grounded unpredictability, the exercise of reasoned judgement rather than the display of correct behaviour. (1986, p. 13)

In contrast, Helen felt that the school culture did demand a certain “correct behaviour”. This reveals that not only did Helen feel constrained but that her knowledge of the school culture overrode her judgement about which video would be most pedagogically effective. While other teachers, such as Carl and Alison, mentioned avoiding videos on the basis of language that might be seen as taboo, Helen’s example showed the clearest tension between PCK and context. There is room to investigate this phenomenon more deeply.

7.3 Macro context

> The macro context is defined by social, political, technological, and economic conditions. These include the rapid technological developments worldwide, which require constant learning, as well as national and global policies that, in the case of teacher technology integration, become especially relevant. (Porras-Hernández & Salinas-Amescua, 2013, p. 228)

The factor most cited by the participants at this level, namely the key bounding and motivating role of the national and state government curriculum documents, was addressed in Section 6.3. Teachers considered the state mandated curriculum documents as the key determinant in what content they included in units of work, and therefore the subject matter of videos they chose. In short, Troy declared “what we do in this curriculum in Victoria dictates what videos I'll [create]” (I2).

The macro-contextual factor not yet discussed that emerged as an important influence on teacher selection and use of instructional videos was the dominant platform from which the teachers sourced the majority of the video content (50 of 58 videos selected; see Appendix G), namely YouTube. The rest of this section will be devoted to a discussion of the YouTube platform, and the algorithmically mediated exosystems that mediate the labour of selecting and using instructional videos.

Rosenberg and Koehler (2015a) encouraged researchers to use the context framework on which this chapter is based “to draw inferences about what aspects of context have been the subject of comparatively little scholarship” (p. 452). Despite a comprehensive search, I was not able to discover any research exploring the influence of the YouTube platform on the work of teachers in mainstream contexts. In exploring this impact, I hope to shed light on the human-software interactions involved in the use of algorithmic platforms, and to encourage a more critical perspective of algorithmic platforms more generally in education. Interestingly, Rosenberg and Koehler (2015a) described macro-contextual factors as “the most distal” (p. 450), but despite the macro factor of the YouTube algorithm being operated and designed at great distance, it was experienced at a very personal level.

The YouTube platform is a complicated piece of software, and Berry (2011) suggests that to bring software from the hidden to the visible, we should consider (i) what it is, (ii) where it has come from, and (iii) what it is doing. This section seeks to explore these three questions to the extent that it is possible for the YouTube platform, in order to better explain the algorithmic influence on teacher work. In exploring the role of algorithmic systems in education, Edwards (2015) suggests we go some way to satisfying "a clear need to examine the ways in which software is entangled in curriculum-making practices in relation to forms of representation and the nature of knowledge" (p. 276). Mishra and Henriksen (2018) have termed such entanglement of practice and technology "deep convergence" (p. 114). While teachers certainly use their professional knowledge to navigate and select videos from the YouTube platform, there is a hidden algorithmic factor that both influences the kind of content available, and mediates the content that is surfaced to teachers.

This section of the thesis begins with a brief history of the YouTube platform, then provides an outline of how it was used by the teachers in this study and their perceptions of it. The section finishes with an analysis of the YouTube recommender algorithm and its influence on the type of content that is published. Suggestions are made for further research into the commercial interactions that underpin the influence of algorithmic platforms on secondary education.

7.3.1 YouTube - a hybrid system

YouTube is by far "the world's largest platform for creating, sharing and discovering video content" (Covington et al., 2016, p. 191). Founded in 2005 by three employees of PayPal and purchased by Google shortly after for $US1.65 billion, YouTube has grown to be the dominant video hosting platform in most parts of the world in which the platform is not banned. Alexa Internet (2020) ranks YouTube as the second most visited website in the world behind only its parent company Google. While estimates vary wildly in popular media, by the end of 2016 YouTube hosted almost 4 billion videos and that this number was steadily rising (Bärtl, 2018).

YouTube was not initially designed as an educational resource. It is a broad-based entertainment platform (Paolillo et al., 2019), that with the introduction of paid advertising has gradually morphed from a focus on participatory culture to a "hybrid commercial environment" (Lobato, 2016, p. 357) based on generating advertising revenue. Some have described this as a "fall from grace" (Cunningham, 2016, 5:46) in that the original amateur vision of the site has arguably been compromised by the increasing commercialisation of the platform. In January 2020, Google CEO Sundar Pichai revealed that YouTube generated $US15.1billion in revenue in 2019, "painting a picture of a profitable venture" (Birnbaum, 2020, paragraph 2) whereas as late as 2016, YouTube's CEO Susan Wojcicki was reporting that YouTube was still in an "investment stage"(cited in Arthurs et al., 2018, p. 7). Because it still acts as a social network, allowing user interactions and amateur uploads, it is perhaps best described as a "unique middle ground between industry practices and popular culture" (Arthurs et al., 2018, p. 7). However, Bärtl (2018) found the majority of views are attracted by channels tagged as *Entertainment*, *Music*, *Gaming*, and *People & Blogs*, highlighting the site's primary role as an entertainment platform.

Through random sampling, which is notoriously difficult given that the YouTube Application Programming Interface (API) has a tendency towards preferencing popular channels, Bärtl (2018) estimated that in 2016 1.3% of channels and 4.4% of video uploads were tagged (categorised by the uploader) as “educational”. YouTube has actively sought to promote this, offering $US20 million funding for successful education channels to grow (McMullan, 2018) and offering a free online course in promoting educational content on the channel (YouTube, 2019). It should be noted, however, that teachers in this study re-purposed other videos for educational means on seven occasions (V3, V4, V5, V6, V14, V39, & V49). This repurposing of technologies is a key hallmark of TPK according to Koehler et al. (2013) who argued that “teachers need to reject functional fixedness and develop skills to look beyond most common uses for technologies, reconfiguring them for customized pedagogical purposes” (p. 13). An important consideration for teachers, and for the potential impact YouTube’s dominance may have on education, is that the platform is largely unregulated and educational videos are published “without editorial oversight” (Arthurs et al., 2018, p. 5).

7.3.2 YouTube in teacher practice

In the data collected for this study, a surprising majority of the videos teachers chose to use in their teaching practice (50 of 58) were sourced on YouTube. Table 13 shows the level of dominance this one platform has over all others in terms of specific videos teachers reported using in their teaching practice. While Cunningham et al. (2016) found that 92.1% of schools in Australia reported using YouTube in a twelve-month period and that it was the greatest competitor to commercial educational video platforms, this level of dominance is still surprising. One caveat is that Maths Pathway is a system that provides many videos, and only one sample was taken, even though in Louise’s junior Maths class Maths Pathway was the main source of video content. This was done to avoid skewing the data from one atypical source, particularly given these videos were usually provided to students by the system, not as a result of Louise’s decision making. Similarly, other teachers mentioned using a series of YouTube videos, such as Margaret who used a series from the Bible Project, and only one video was taken as a sample on that occasion also. Of the ten videos that were used during classes that were observed, rather than reported during interviews, nine were shown through YouTube's platform, and one through ClickView (note that Carl used 3 videos and Lucy 2 in their respective observation lessons, while Alison and Melissa chose not to show the videos they had planned, hence the count of ten). This shows that in education, as in society more broadly, "YouTube is thoroughly mainstream" (Lobato, 2016).

Table 13:

Video Platforms Used by Teacher Participants

Platform	Video count
YouTube	50
ClickView	3
ABC iView	1
Local Files	1
School System	1
Maths Pathway	1
The Guardian	1
Total	58

YouTube's dominance existed even when teachers were unaware of their reliance on the platform. For example, Melissa initially claimed her primary search instrument was ClickView, and mentioned both Netflix and DVDs. Indeed, she said “I’ve had more success externally, as opposed to sitting on YouTube” (I1). Yet, three of the four specific videos she reported using in class were hosted on YouTube, and by the end of the study she recognised “I feel that I do use YouTube the most” (Melissa, personal communication, 19/1/2020). Alison claimed she tried to use ABC Splash as a source of videos, but when asked to check the ones she used in class, they were all from YouTube as well. The ubiquity of the tool seems to have made it what Cox (2008) has termed *transparent* technology. Margaret certainly mused that times had changed and that video technology had become more commonplace since teachers “had to pass our 35mm film projector’s licence during Dip Ed” (personal communication, 16/9/2019).

Yin (2009) emphasises the need for data triangulation in case study research, and given I was surprised by the lack of ClickView use in the dataset given the fact both schools paid for the service, I sought further data. With the permission of each principal, IT support staff at each school ran ClickView sitewide usage reports for 180 days, a period roughly equivalent to one school semester. The usage statistics suggest that the service was well used, with 872 videos viewed by staff at Station College and 4173 viewed by Wayfarer staff. However, both reports suggest that the most watched videos were motion pictures either studied in English or Religious Education, or watched in evenings, possibly for entertainment. In terms of the Station results, eight of the top ten most watched videos were feature films. In the Wayfarer statistics, most videos were either feature films or locally made videos such as student leadership candidate speeches and school events. Relatively few could be considered instructional videos. This evidence suggests that teachers look to ClickView for long form films, but not for instructional videos, consistent with the data collected from teachers. As was expected, the ICT manager at

Station College confirmed that the school did not keep data on the number of YouTube site visits or videos watched, so no comparison was possible.

While restricted to a small number of cases in only two locations, the sheer dominance of YouTube as a source of instructional videos suggests this usage is unlikely isolated to the teachers in this study. Edwards (2015) suggests that software like the YouTube platform exhibiting such "taken-for-grantedness" (p. 266) is worth investigating, as its influence on curriculum making may be under-explored.

7.3.2.1 YouTube native?

The videos teachers sourced on YouTube were mostly produced for the platform (34), in that YouTube was their sole or primary place of publication, so called *YouTube-native content* (Rieder et al., 2018). Less common were videos originally produced for television (9), educational DVDs (3), and independent websites (2) either uploaded by third parties or the producer themselves. Despite investigation, the origins of one video remained unclear (see Appendix G). The origin or original audience of videos is important as content made specifically for YouTube is more likely to adhere to platform vernaculars (Gibbs et al., 2015), meaning the dominant discursive patterns and particular factors that lead to popularity.

7.3.3 Teacher perceptions of YouTube

The teachers in this study identified range, familiarity, and ubiquity as the main advantages of YouTube. Carl and Lucy were the most enthusiastic proponents of YouTube, with Lucy suggesting "there's nothing you can't learn off YouTube" (I1) and Carl calling it "amazing" (I1). Margaret saw YouTube as a source of videos that students liked, about topics that students find hard to be interested in, like the Gospels in her Religious Education class. This may be a result of the algorithmic preference the YouTube platform has for engaging content, which the experienced teachers saw as missing in past educational videos. Dennis recognised that there was some quality content, like the *Crash Course* series, that was only available on YouTube. The search function of YouTube was familiar to the teachers, and they found it intuitive, despite the fact that none of them used the advanced search features. Carl described this as an important reason to use YouTube over ClickView, because he “looked at ClickView when I first started last year it's just that YouTube is, I'm just more familiar with the program” (I1). Finally, Troy saw the benefits of YouTube as a hosting site, because it not only provided him with a small supplementary income, but because it had a global reach. Ultimately, the teachers saw YouTube as an easily accessible, ostensibly free, reliable, and familiar source of instructional videos.

Despite this generally positive view of the YouTube platform, the teachers all expressed reservations as to its use. The lack of stability or permanence of YouTube content was a common concern. Content on YouTube is at times copyrighted TV programming, reproduced without permission, a feature “unanticipated” (Arthurs et al., 2018, p. 4) by YouTube at its inception. Indeed, uploading of copyrighted material was the cause of a major lawsuit against YouTube by Viacom in 2007 which resulted in the introduction of content ID (Paolillo et al., 2019). Content ID allows producers to assert ownership over copyrighted material and the revenue it generates. Because of this, videos useful to teachers are at times taken down. This was borne out when Lucy shared a URL to a video on lino printing she had used weeks before her interview in a Year 7 Art class, only to find it had been removed. Her response was “yes that does happen from time to time, there are so many clips to choose from, I am sure I will find another one” (personal communication, 19/9/2018). This reality that labour could be lost because of the nature of the platform was seen as a frustrating but unavoidable reality. Dennis reported using third party download sites to save copies of videos to his computer hard drives in order to guarantee future accessibility. Such practices, while convenient, highlight the need for clear policies and teacher training around the legalities of copyright as while they violate the YouTube terms of service, they do not violate Australian law. Nevertheless, the transience of YouTube content was an external factor that affected teacher practice, either by encouraging questionable practices or by forcing teachers to find replacement videos, meaning an increase in labour.

As a commercial enterprise, YouTube profits from the sale of advertising. This means that students are often shown advertisements tailored to the profile of their teacher when videos are displayed on a projector screen, and tailored directly to them during playback on a personal device. When asked how often this actually happens, Carl replied "all the time, it's very annoying, I just have to remember to skip them" (I2) and Lucy scrambled to stop an advertisement playing during her observation (see Section 6.4.4.2). The advertising that forms an integral part of the YouTube ecosystem arguably raises concerns that at the very least, students are being marketed to in classrooms, which perhaps should be non-commercial spaces. None of the teachers reported that advertising acted as a major disincentive to the use of YouTube, but more research could be done into the effect this has on students.

YouTube in English is dominated by US content and as such American cultural norms are part of the platform vernacular. Troy expressed concern to his class that an Indian YouTube creator (*Manocha Academy*) had chosen to use the US Calorie measurement of energy rather than the international standard kilojoule despite acknowledging the international standard in the video. Troy suggested to the class that this was "probably because he knows most of his audience will be American" (O). Again, while this was cited as a reservation with YouTube by Troy, it was not enough to disincentivise him from using the platform.

Most teachers were particularly concerned about the factual or ideological reliability of YouTube content, because of the largely unregulated nature of the platform. While this lack of regulation does allow content from marginalised and underrepresented voices to be published (Arthurs et al., 2018), it also means that extreme or unreliable voices are rarely moderated and are at times preferentially surfaced (Rieder et al., 2018). Melissa, Dennis, Helen, Margaret, and Carl all cited questionable factual reliability as a concern on YouTube. For some of the teachers, notably Melissa, Margaret and Dennis, this meant an increase of labour due to their feeling of responsibility to fact-check the videos (see Section 6.4). Melissa explained this succinctly:

> I feel that I do use YouTube the most, however when discussing reliability/validity, this platform definitely requires more in terms of time and research for the teacher in order to ensure it is appropriate for their students. (Melissa, personal communication, 19/1/2020)

It was interesting that concern about YouTube's factual and ideological reliability did not necessarily correlate with an increase in fact-checking or previewing behaviours among teachers (see Section 6.3).

7.3.3.1 YouTube videos and factual accuracy

The accuracy of YouTube educational videos is contested. In the past, it has been described as "a vast wasteland of garbage" (Jones & Cuthrell, 2011, p. 81). The risk of poor information is personified by the unfortunate sociology student in Tan and Pearce's (2011) study who was sure she had found a reliable explainer video on feminism, only to be told it was in fact a parody produced by a US right-wing extremist group (see also Section 2.2.1). At this stage, most research into the factual accuracy of YouTube instructional videos has been completed in the field of medical information, and has returned mixed findings. Fernandez-Llatas et al. (2017) found that accurate videos tend to become more popular, and therefore appear higher in searches in the medical fields they studied. However, a recent systematic review (Okagbue et al., 2020) found that user engagement was higher with low-quality medical videos and that only 36.3% were uploaded by medical professionals or organisations. Furthermore, Daly et al. (2016) concluded that “many medical animations currently present on YouTube.com are very artistic but often bear little relation to reality” (p. 201). Several studies (Ajumobi et al., 2016; Hassona et al., 2016) have found that there was no relationship between popularity of a YouTube video, a metric which was used by Carl and Troy as a measure of quality, and its thorough delivery of medical information. Concerningly, Rieder et al. (2018) found that controversial right-wing commentators are consistently recommended to YouTube users despite having lower view counts, meaning that as a primary source of knowledge, YouTube is at best questionable. More research needs to be done into the reliability of popular videos in topics other than medical fields. Certainly, however, there is enough doubt to suggest that teachers ought apply their own content knowledge to check the accuracy of instructional videos, or cross check facts with reliable sources, as was shown by Melissa (see Section 6.3). Because of the lack of editorial oversight” (Arthurs et al., 2018, p. 5) with which YouTube videos are typically produced, this is more pertinent now than three decades ago when Shulman (1986) suggested young teachers needed to be able to deal with “flawed or muddled textbooks” (p. 7).

Despite the lack of editorial control on YouTube, Helen found that on one occasion the comments feature helped her to identify a faked experiment in a video she was considering.

When previewing an uploaded video of the early 2000s British entertainment science show *Brainiacs* (V26), purportedly demonstrating the reaction of Alkali metals in water, she discovered in the comments under the video that “they put explosives in the bottom of the bath and I'm sort of going, so do I use it because I know it's fake?” (I1). The show’s producers confirmed in 2006 that they had indeed put plastic explosives in the bath because the explosions were not sufficiently impressive (Goldacre, 2006). Helen drew on her content knowledge to conclude that, while the experiments were faked, they represented a theoretically possible phenomenon, and so she continued to use the video. In this particular instance, the social element of YouTube’s platform, namely the comment section, alerted Helen to a scientific controversy in a video produced by traditional media. In this way, while the YouTube platform is often criticised for its lack of editorial control (Holmberg et al., 2018; Landrum et al., 2019; Mohammed, 2019), the ability to comment and read the comments of others may represent an opportunity to crowd-source fact-checking, or at least flag the possibility of unreliable content. While Helen’s example is unique in this study, it illuminates a path for future research analysing the reliability of YouTube comments on educational videos and whether they may prove to be reliable sources of teacher (or student) knowledge.

This section has evaluated teacher use and perception of YouTube. Given that it has been established that YouTube dominated as a source of instructional videos, it is important to investigate the nature of the platform’s ecosystem, and the work of the complex algorithm that mediates what content teachers see.

7.3.4 YouTube: an algorithmic platform

This section describes the current industry beliefs concerning the mechanism of the YouTube search and recommender algorithms and makes suggestions as to the influence this may have on teacher use of the platform. As has already been described, most teachers in this study used a search and scroll method to find instructional videos, entering key words into YouTube's search bar and selecting from the resulting list (see Section 6.3.4). This means the software underpinning the creation of this list, and the subsequent recommendations that drive most YouTube watch time (total minutes watched by a user in each log in session), are important factors framing the application of teacher knowledge.

7.3.4.1 A black boxed mystery

The YouTube algorithms have been described as "black boxed" (Bishop, 2018, p. 73) and a "mystery" (Cunningham et al., 2016), in that YouTube has not publicly revealed the exact mechanism by which it preferences certain videos. Nevertheless, it is certainly one of the "most sophisticated industrial recommendation systems in existence" (Covington et al., 2016, p. 191). The lack of unambiguous knowledge about the algorithm poses methodological difficulties in analysing its impact (Arthurs et al., 2018), compounded not only by the fact that it is difficult to reverse engineer the algorithm but that, when studying its effect, researchers must be aware that content creators respond not to the reality of the algorithm's behaviour but to their beliefs about the algorithm (Bishop, 2020; Rieder et al., 2018). A further complication is the algorithm's dynamic character, in that YouTube refines the algorithm regularly, and it is optimised for the individual user (Gielen & Rosen, 2016), problematising the practice of studying it from a neutral perspective, as some have tried to do (Fernandez-Llatas et al., 2017; Paolillo et al., 2019).

Nevertheless, Covington et al. (2016), who were employees of Google working on the recommender system at YouTube, presented a public paper giving some insights into the algorithm. There is also broad consensus from industry players as to which practices optimise video success in the algorithm driven YouTube environment.

7.3.4.2 An algorithmic ecosystem

The YouTube search and recommendation algorithms work to rank videos and channels by their likelihood of maintaining a viewer's attention. This is based on search terms, the prior watching behaviour of the user, and the prior performance of candidate videos with other users with similar profiles. At one level, this has a positive impact in that it discourages clickbait, meaning "deceptive videos that users do not complete" (Covington et al., 2016, p. 195). In other words, were YouTube simply to return videos with the closest matching title and description to a search, users would be overwhelmed by poor quality or deceptive videos tagged with common search terms. In this way, the algorithm can be considered the kind of AI that helps make a teacher's work "less hard" (Selwyn, 2019, p. 124).

In 2012, YouTube changed the definition of video popularity from a simple count of likes to a measure of total watch time (Paolillo et al., 2019). YouTube CEO Susan Wojcicki confirmed in 2016 that changes to the algorithm meant that preference was given to videos that kept viewers on the YouTube platform longer (Bishop, 2018). While number of minutes watched is too simplistic and other factors such as session starts (a video that brings a viewer to the site) and session ends (a video during which a user exits the site) are also considered (Gielen & Rosen, 2016), YouTube's own advice to creators highlights the trend towards watch time being the prime metric, explaining that “we look at which videos have driven the most watch time, and engagement for a search phrase” (YouTube, 2017).

This deliberate focus on watch time encourages retention over instructional efficiency for educational content providers. For example, a concise worked example video running just a few minutes that satisfied a student’s instructional need and encouraged them to return to their homework might be “punished with obscurity” (Bishop, 2018, p. 75), despite its seemingly masterful educational use of the platform. This is because while a *session start* is rewarded, a *session end* is a negative metric to the algorithm (Gielen & Rosen, 2016).

7.3.4.3 A controversial algorithm

A result of this focus on total session watch time is that at times, popular videos are pushed down the rankings in favour of videos produced by lower budget, YouTube-native commentators. Data scraping research has found that at least with regard to broad searches of political topics like *Syria*, *Trump*, and *Refugees*, the search results tend to favour videos by right-wing commentators who Rieder et al. (2018) have described as “a new elite that thrives on controversy and dissent” (p. 64). For example, in that study, a simple search for *Islam Australia* returned a video posted by an anti-Islam channel at the top of the list. This was despite the second-placed video, one in which bystanders are encouraged to resist anti-Muslim hatred, having over ten times more views. Official news sources were rare in the top twenty results, with only the ABC, Al Jazeera, and Russia Today regularly returning top 10 results. In another search on the controversy known as *Gamergate*, Rieder et al. (2018) found that the video with the highest view count, a left-wing talk show, was consistently number 14 in search returns. This pattern of right-wing, YouTube native, controversial commentators being preferenced in political topics is of interest to teachers and students of Humanities subjects like History, Religious Education, and Politics. Indeed, Islam in Australia is precisely the kind of topic that Melissa and Alison, inexperienced teachers of Religious Education with self-reported lower CK, reported teaching in their Religious Education classes.

Teachers with higher CK, like Dennis, were able to skilfully navigate these search results, using the controversy and bias as a teaching tool (See Section 6.5.4). On the other hand, teachers with low CK who use videos as a source of knowledge, may be led by the search algorithm to view these controversial videos lacking editorial oversight rather than more measured content from traditional providers. Recall that Carl used videos with such controversial titles as *Why does Australia FEAR China* (capitals in original) that he had discovered on YouTube. There is no suggestion in the literature that YouTube has an institutional bias towards controversial videos but that the algorithm may preference them as a result of the human decision to focus on user engagement (Tufekci, 2018). In this way, the work of teachers is subject to the "values, idea, and politics" (Selwyn, 2019, p. 92) of the algorithm designers, in this case, the preferencing of watch time.

It should be noted that while usually autonomous, YouTube programmers have manually adjusted the algorithm in the past when this automated focus on increasing watch time has produced alarming, even disturbing results. Two notorious examples were when the algorithm was discovered to have fed videos of children to paedophiles who would at times leave sexualised comments (Fisher & Taub, 2019) and when it was found to have delivered violent content featuring children's characters to children (Subedar & Yates, 2017). This led to changes in the algorithm, the requirement of producers to declare if the content was designed for children, and the banning of comments on most videos featuring children. You Tube also created a dedicated version of YouTube for children called *YouTube Kids* which effectively filtered out violent content. More recently YouTube has announced that it is working to encourage users away from conspiracy content like flat-earth proponents by recommending “more reliable news sources” (Bensinger, 2019, paragraph 5). Episodes like this display both the unintended side-effects of AI algorithms, and the reality that human intervention is often in the form of reactive troubleshooting rather than deliberate planning.

7.3.4.4 Impacts on content producers

Given that an extremely small number of educational YouTube channels manage to become successful (Bärtl, 2018) and gain financial and social returns (Bishop, 2018), producers face a tension between effective education and satisfying the vernacular of the platform’s algorithm. Derek Muller, who as a researcher at UNSW concluded that the most effective instructional videos in science are not the ones that students like most (Muller, Lee, et al., 2008), now runs a profitable YouTube science channel, Veritasium. He explores this tension in his video *How should we teach science?* (Veritasium, 2017), explaining that:

> I have a double bottom line where I don’t get paid, my living does not come from people learning necessarily, it also comes from people watching my videos. So, if I always went the route of forcing people to think hard and potentially learn more but not share or enjoy the video as much, then I think the channel wouldn’t have grown as much as it has. (3:23)

Even more directly, the YouTube creator studio lesson on starting an educational channel states “if you want your YouTube videos to be successful you have to play by the YouTube rules”

(YouTube, 2019, Lesson 1), and “the longer you keep an audience watching, the more your content may get surfaced in search” (Lesson 3).

Paolillo et al. (2020) argue that popularity itself can be considered evidence of an effort on the part of a producer to satisfy the YouTube algorithm. The algorithms determining search returns and video recommendation to a large degree determine how much a YouTube channel generates in income through Google’s AdSense revenue partnership program. Content producers get paid per ad that plays before, or during, their video (unless it is skipped by the user). The more times a video is seen, the more chances a content producer has to generate advertising revenue. Secondary revenue streams, such as sponsorships and in-video product placements, are also attracted by view count and advertiser-content synergy (Arthurs et al., 2018).

The danger in having a focus on watch time stems from findings that the most entertaining videos are not always the most efficient at conveying information (Muller, Bewes, et al., 2008). For example, ten Hove and van der Meij (2015) found that popular educational videos on YouTube were more likely to include background music than unpopular ones despite research on coherence suggesting that background music hinders learning (Kopiez et al., 2013; Moreno & Mayer, 2000). Furthermore, the YouTube tutorial on creating educational content includes a suggestion that taboo topics are more popular (YouTube, 2019, Lesson 1). Moreover, the YouTube algorithm preferences videos that hold a user on the platform rather than those that efficiently instruct a learner in one short clip. This stands in direct opposition to the almost unchallenged findings of the research in the systematic review conducted for this thesis (see Chapter 3) and the participants in this study, who advocate that videos should be as short as possible.

Lobato (2016) contends in his work on multi-channel networks that while the effects of the algorithm and increasing professionalism of YouTube "are not immediately visible to the end user of YouTube… they are important because they are subtly recalibrating the way the digital video economy works" (p. 357). Teachers may be led to believe in "the myth of platform objectivity" (Bishop, 2018, p. 77), when the reality is that to both protect the platform from abuse and to improve advertising revenue through user watch time, YouTube's algorithm "serves as a gatekeeper" (Paolillo et al., 2020, p. 2759) influencing the kind of content that is surfaced in searches or is recommended. Because, as Tufekci (2018) so bluntly put it, "for all its lofty rhetoric, Google [YouTube's parent company] is an advertising broker, selling our attention to companies that will pay for it" (p. 6).

All of this means that the vast and growing corpus of educational videos on YouTube may be influenced by a dominant macro-contextual factor that shapes new content and the surfacing of existing content, preferencing popularity over pedagogical practice. Apart from Troy, who maintained his own YouTube channel and watched his channel statistics "religiously" (I2), the other participants demonstrated no understanding of the mechanics of YouTube's algorithmic ecosystem. For better or worse, therefore, the ecosystem of YouTube is a hidden context within which teachers make pedagogical decisions.

7.3.5 The ordinariness of YouTube: a false transparency

The search and scroll technique teachers reported relying on to find videos means the YouTube algorithms play a role in determining which content teachers, and by extension students, may see. While Chapter 6 outlined the types of knowledge teachers use to select from among the videos that are surfaced, it also showed that teachers relied on the YouTube search function to first create a list of candidate videos. It is useful to revisit the participants' descriptions of this search and scroll process:

> I just do my usual jump into YouTube, put it in the keywords 'public relations campaign' or 'public relations PR stunts' another key word to sift through the videos on YouTube. (Carl, I1)
>
> Generally, I just YouTube it, click and see if there's something that's appropriate… I put in canonisation and that was the first one to come up. (Alison, I1)

The impact of the algorithms on teacher choice is hard to quantify. However, recall that due to this process, Troy was unaware that one of his trusted producers (Mike Sammartano) had created a video covering exactly the topic Troy had searched for. Because it was not surfaced by the YouTube algorithm in his search results, Troy had not seen it and therefore not shown it (see Section 6.3). Troy still chose what he thought was a quality video, but his choice was mediated by the software algorithm. This algorithmic influence of the YouTube platform, combined with the Troy's decision making is a clear example of what Edwards (2015) called human-software entanglement. The influence of the algorithm is hidden from users (Bishop, 2018) and given the routine way in which teachers described searching, often using the word 'just' (see Section 6.3), this influence was not considered by the teachers.

The black-boxed nature of the algorithm combined with the taken-for-grantedness (Edwards, 2015) apparent search and scroll method revealed in this study has implications for the way in which transparency is conceptualised in the TPACK framework. The YouTube platform satisfied the definitions offered of 'transparent' technologies including that it is clearly a "ubiquitous part of the teaching profession's repertoire of tools" (Cox, 2008, p. 79). However, given the hidden algorithmic influence this transparency could be said to be false. The teachers had indeed stopped considering the YouTube search technology in their reasoning, meaning that TPACK had theoretically become PCK (Koehler et al., 2013). However, the technology was still having an impact on the outcome on their decision making by limiting or selecting those videos that would be surfaced in searches and recommendations, and influencing the kind of content produced by creators, all without the knowledge of the teacher.

To a large degree, because of the black-boxed, confidential, and dynamic nature of the algorithms (Bishop, 2018; Gielen & Rosen, 2016) teachers can never fully know the influence AI platforms are having on their decision making. While Porras-Hernández and Salinas-Amescua (2013) suggest that macro contexts include “the rapid technological developments worldwide, which require constant learning” (p. 228), ultimately AI algorithms are unlearnable, because the inner logic of the system is both constantly changing and fundamentally hidden. When considering AI based software, perhaps it is inappropriate to suggest that they could ever become transparent in the way that straightforward technology like overhead projectors and word processors might (Mishra & Koehler, 2006). Current TPACK models fail to consider the growing yet hidden work of algorithmic software acting upon teacher reasoning without the teacher’s awareness. This aspect of the broader context in which teacher knowledge is enacted is a key contribution of this study.

7.4 Chapter conclusion

This chapter highlights the role of contextual factors beyond teacher knowledge on teacher selection and use of instructional videos. Applying the contextual framework proposed by Porras-Hernández and Salinas-Amescua (2013) and expanded upon by Rosenberg and Koehler (2015a), these factors were understood in micro, meso, and macro spheres. Some contextual factors that overlapped with teacher knowledge were discussed in Chapter 6, such as the knowledge of learners and curricular knowledge. Regardless, this chapter identified four important contextual factors emerging from the data not previously identified in Chapter 6 and described their impact on teacher video selection and use. Out of these emerged five findings.

7.4.1 Technology is not a barrier to simple video use

In the two well-equipped schools in this study teachers did not experience any first order barriers (the availability of hardware, software and internet) to their use of instructional videos, reflecting the findings of Ertmer et al. (2012) that these are becoming less common in developed educational contexts. While in Section 7.1.1 it was reported that Margaret, Troy, Carl, Melissa, and Helen experienced minor frustrations, all were overcome relatively quickly and easily. Only in Helen's class, the sole observation during which students were given control of playback, were more technical difficulties observed. Interestingly, Margaret, Carl, and Alison cited potential first order barriers such as unreliable student laptops and internet connections as reasons to use projectors. While there is not enough data in this study to make a strong claim, it is possible that technology was not a contextual barrier to these teachers partly because they used relatively simple technology, rather than "powerful communication and collaboration tools" (Ertmer et al., 2012, p. 424).

7.4.2 Policies do not restrict teachers

The data revealed that not only were school policies regarding videos rarely read by teachers, they did not contain restrictions pertaining specifically to instructional videos. The participants, including Station deputy principal Dennis, only knew of procedures regarding the showing of adult rated programming such as feature films and a proscription against the use of videos as time-fillers. Instructional videos are not covered by either proscription. Unlike in other jurisdictions that restrict the platforms teachers can use, the teachers were not restricted by policy.

7.4.3 Perception of time poverty is a principal barrier to knowledge enactment

While this study focuses on the role of teacher knowledge in the selection and use of instructional videos, the data revealed that the teachers saw a perceived lack of time as the principal barrier to the development and enaction of their knowledge. For example, when asked what prevented Dennis from exploring the segmenting facility in the ClickView platform, which allows teachers to integrate learning activities into playback, he said “everything else, the fact that there are so many things to do and there’s a limited amount of time” (I1). In other examples, Carl, Helen, and Troy knew they *should* check the factual accuracy of the videos they chose, but felt they lacked the time. Shulman (1986) suggested that knowledge, in particular content knowledge, was the essential ingredient for teachers to make effective pedagogical choices, including when selecting curricular materials like videos. This study shows that teachers need the time (or time management skills) to enact that knowledge before it is impactful. Reinforcing the findings of Philipp and Kunter (2013), when teachers felt time-poor they compromised, selecting from amongst the tasks they saw as part of the labour of teaching while neglecting others. Such neglected tasks variously included pre-watching videos thoroughly, fact checking, video enhancement, and creating their own targeted videos. This shows that a focus on teacher knowledge alone may not be enough to improve teacher practices concerning instructional videos. However, such knowledge may help teachers prioritise the tasks they select.

7.4.4 Selection of videos is enacted as an individual, rather than collaborative labour

A surprising finding in this study was the extent to which the selection of instructional videos and the subsequent lesson planning was conducted by individual teachers rather than teaching teams. Despite most teachers initially claiming to share videos and plan collaboratively, the data revealed only six of the 58 videos teachers reported using were sourced from or with colleagues. This meant that despite teachers, in particular those in the early stages of their careers, explaining that the process of finding videos was at times difficult and time-consuming (see Chapter 6) they still replicated that labour on an individual basis. This was not the case with all resources, as teachers reported using common assessment tasks, PowerPoint presentations, and curriculum documents. However, Louise explained that "each teacher needs to find their own [videos]" (I2). Instructional videos seem to constitute a special kind of teaching resource used as part of a private, rather than shared, repertoire.

Given Eisner's (2002) suggestion that phronesis is often developed "through deliberation with others" (p. 382) and Shulman (1987) lamented the lost "aha" (p. 19) moments of teaching due to a lack of documentation, this finding appears particularly important. Teachers may well benefit from opportunities to share the instructional videos they have used, and the pedagogical uses of these that have proven effective. The practices reported in this chapter not only necessitate replication of labour but fail to pass on the "learned art" (Helen, personal communication, 11/9/2019) of video selection and use from experienced to novice teachers.

7.4.5 Algorithmic platforms represent an under-examined context

A large part of the discussion in this chapter concerns the algorithmic nature of the YouTube platform and its role as a macro-contextual factor mediating the selection of instructional videos. The majority (50 of 58; see Appendix G) of videos that teachers reported using in this study were sourced from YouTube. It is surprising, therefore, that the impact of the YouTube platform on the work of teachers is such an under-examined contextual factor.

This chapter has revealed that apart from Dennis, who critically evaluated the way the platform shaped the representations of his subject area, the search strategies used by the teachers indicated an uncritical view of the platform algorithms. The reality is that while the algorithms "are not immediately visible to the end user of YouTube… they are important because they are subtly recalibrating the way the digital video economy works" (Lobato, 2016, p. 357). These effects include preferencing controversial or taboo content (Rieder et al., 2018; YouTube, 2019) and focusing on watch-time rather than educational efficiency (Gielen & Rosen, 2016; Whistler, 2018; YouTube, 2012). These effects emerge out of the "values, ideas, and politics" (Selwyn, 2019, p. 92) of the designers of the algorithm and can be adjusted when the resulting behaviour of the algorithm is deemed undesirable (Mohammed, 2019; Paolillo et al., 2020; Subedar & Yates, 2017; Tufekci, 2018). The resulting ecosystem of creator, algorithm, designer, teacher, and student represents a particularly complex human-software entanglement (Edwards, 2015). There is a need to more deeply investigate this entanglement, particularly the impact of the algorithm on content producers, and evaluate the quality of the educational content surfaced to teachers in searches in order to cast light upon any potentially undesirable impacts on education.

The commercially hidden, black-boxed (Bishop, 2018) nature of the YouTube algorithm also has implications for the TPACK construct. In particular it casts doubt on the proposition that when the use of technology becomes “commonplace” (Mishra & Koehler, 2006, p. 1023), that technology stops being considered emerging technology, and becomes instead transparent. This study clearly reveals that the use of YouTube was indeed commonplace amongst the participants and the search function in particular was taken for granted (Edwards, 2015). Regardless, the workings of the algorithmic platform remained hidden and at times unconsidered. Such a status might better be described as a false transparency in which teachers use a technology as if it is transparent without recognising the influence the hidden aspects of the technology might be bringing to bear on their practice. It is unlikely that YouTube is the only such falsely transparent technology, and this finding may be a useful lens with which to interrogate other platforms.

In summary, this chapter has explored factors impacting on teacher selection and use of video beyond teacher knowledge. In doing so, this thesis recognises that an answer to the central question *how does teacher knowledge influence the selection and use of instructional videos* does not give a full account of the phenomenon without a consideration of the context within which that knowledge is enacted. Using the contextual framework proposed by Porras-Hernández and Salinas-Amescua (2013), this chapter explored factors in the micro, meso, and macro-contextual spheres, showing that teacher knowledge is not enacted in isolation, but is empowered, constrained, and altered in hidden and apparent ways by the contexts in which teachers work.

Chapter 8: Conclusion

This study sought to explore the question of how teachers select and use instructional videos, and “what teachers knew (or failed to know) that permitted them to teach in a particular manner” (Shulman, 1987, p. 5). The literature review found that while the use of videos had been studied extensively in pedagogical contexts like flipped learning and MOOCs, the literature is silent as to the ways in which teachers in mainstream secondary schools select and use these increasingly popular curricular materials in their work. This research begins to address this void in the literature by focussing not only on the practical question of how teachers in mainstream secondary schools select and use videos, but also interrogating the knowledge types they draw on and the contextual factors empowering and bounding that practice. The study ultimately sought to investigate the following question:

RQ: How do teachers select and use instructional videos?

This main question was bounded by two themes, as expressed in two sub-questions:

SQ1: What role does teacher knowledge play in the selection and use of instructional videos?

SQ2: What role does context play in the selection and use of instructional videos?

To address these questions, a multiple case study methodology was employed, examining the practices of nine teachers in two Victorian schools. The teachers taught a variety of subject areas, ranged from a first-year graduate to a 40 year veteran, and reported a range of varying competencies concerning the use of classroom technology. Data collection resulted in the following data set:

- sixteen hours of interview transcripts,
- nine classroom observation records,
- nine follow-up questionnaires,
- sixty-six e-mail exchanges,
- a collection of 58 instructional videos,
- two sets of sitewide usage data for the subscription video service Click-View.

In order to strengthen the analytic generalisability of the work, the analysis was limited to Shulman's (1986, 1987) framework of teacher knowledge and contextual influences on this selection and use, drawing on CLT/CTML as an analytic framework for making sense of teacher wisdom of practice. As a result, some factors such as teacher motivation, aesthetics, media literacy, or school leadership have been backgrounded in this thesis. Future work may more thoroughly investigate these factors.

In addition, this study does not claim broad generalisability of the findings, but instead seeks to offer rich accounts of a small number of teachers in particular contexts. In doing so, it aspires to transferability rather than generalisability, whereby readers may apply the findings to similar contexts known well to them. While not the central aim of this thesis, these rich descriptions of the complex realities of actual teacher labour are also able to problematise some of the context independent experimental principles emerging out of CLT/CTML. In areas of consistent cross-case agreement, this study makes a strong start to theoretical replication, identifying areas for future research which may lead to a more robust, generalisable base for the creation of professional development and policy.

Despite these limitations, the analysis of the data in this study lead to the development of ten propositions in response to the research questions. These are presented as propositions in Table 14 and explored in the sections to follow.

Table 14

Key Conclusions Concerning the Selection and use of Instructional Videos by Secondary Teachers

Theme	**Proposition**
Wisdom of practice	Wisdom of practice, rather than pedagogical scholarship, is the key source teachers draw on when developing knowledge about effective selection and use of instructional videos.
Dominant knowledge types	Well-developed PCK, knowledge of learners, CK, and curricular knowledge contribute to effective selection and use of instructional videos, while TK is less important.
Hierarchical curricular knowledge	Curricular knowledge exists in a hierarchy, determining content and facilitating selection
Knowledge and freedom	In contrast with Shulman's argument that knowledge guarantees freedom, teacher knowledge both empowers and bounds teacher practice.
Working in isolation	Teachers select and use videos in isolation rather than in collaboration with colleagues.
Time poverty and video use	Teachers' perception of being time-poor impairs their ability to select and use videos in optimal ways
Projectors not devices	In order to engage in live contextualisation and maintain control, or to avoid technical issues, teachers display videos on communal projectors rather than individual devices
The dominance of YouTube	YouTube is the dominant source of instructional videos used in mainstream classrooms
Search and Scroll	Teachers often use an uncritical search and scroll technique to find videos
TPACK and false transparencies	Algorithmic platforms like YouTube are falsely transparent technologies

The propositions in Table 14, reveal that the answer to the main research question *How do teachers select and use instructional videos* is not straightforward. Like most questions of teacher practice, the reality of teacher selection and use of videos proved to be messy as teachers drew on a range of knowledge types and were influenced by a range of contextual factors.

Previous literature advocating principles of instructional video selection and use has mostly drawn on either the results of experimental designs that are devoid of contextual influences or alternatively, well-resourced programs using bespoke media (see Chapter 3). In contrast, these findings drawn from teachers in mainstream secondary schools present a messy and context-bound reality in which participants regularly selected videos that were not purpose-designed under time pressure from an algorithmically driven commercial platform. The teachers selected these videos not for a random sample but for specific learners whose attention they felt was at times fleeting.

These decisions were bound by a hierarchy of curricular influences including the mandated state curriculum and school textbooks which the videos needed to complement. Ultimately, the decisions teachers made around the selection and use of instructional videos were informed by a range of knowledge types with well-developed PCK, knowledge of learners, CK, and curricular knowledge identified as particularly important. This knowledge was usually derived from the teacher's wisdom of practice rather than formal pedagogical scholarship. One upshot of this was that experience teaching a particular subject, rather than well-developed TK, was more often linked to effective selection and use of instructional videos.

The next two sections of this chapter explore the propositions in Table 14 grouped under the two subsequent questions that bounded the main research questions, namely:

SQ1: What role does teacher knowledge play in the selection and use of instructional videos?

SQ2: What role does context play in the selection and use of instructional videos?

In Section 8.3 implications emerging out of these propositions are proposed for practice, including professional development and policy. Finally, Section 8.4 proposes future research trajectories emerging out of the study.

8.1 Teacher knowledge and instructional videos

Shulman's (1986, 1987) framework of teacher knowledge, while over three decades old, emerged as a powerful analytical tool when examining the knowledge teachers draw on when selecting and using instructional videos, thereby answering SQ1. By coding the data to Shulman's teacher knowledge sources and types, with the addition of Mishra and Koehler's (2006) notion of TK to this framework, four findings emerged with regard to the way teacher knowledge was used to inform the selection and use of instructional videos. First, the source of most of the knowledge teachers used was wisdom of practice, rather than pedagogical scholarship. Next, I was able to identify the types of knowledge teachers drew on most heavily when selecting and using instructional videos. Importantly, an extension to Shulman's conception of curricular knowledge was identified, namely that curricular sources are understood in a hierarchical relationship. Finally, the finding that knowledge at times bounds and restricts teacher practice problematises Shulman's (1987) notion that knowledge guarantees only freedom. Each of these findings is discussed here, followed by a discussion of three implications for practice.

8.1.1 Wisdom of Practice

Wisdom of practice, rather than pedagogical scholarship, is the key source teachers draw on when developing knowledge about effective selection and use of instructional videos.

Shulman (1987) argued that when developing a knowledge base, expert teachers should reflect on the “growing body of scholarly literature devoted to understanding the processes of schooling, teaching and learning” (p. 10) including studies set in classrooms and context independent cognitive psychological experiments exploring “how the mind works” (p. 11). Chapter 3 outlined this research literature concerning the design and use of instructional videos. However, apart from a general understanding of flipped learning, which most teachers rejected as a viable approach, this study revealed that none of the teachers had been exposed to the research base. As such, when asked what the main source of their knowledge about effective use of instructional videos was, the nine teachers unanimously cited their wisdom of practice. This means that, despite the ubiquity of instructional videos in teacher practice, their use is determined by the trial and error of individual teachers rather than knowledge of the research base. This highlights the aspirational nature of Shulman’s knowledge base in that it represents state-of-the-art rather than the state-of-the-actual.

8.1.2 Dominant Knowledge types

Well-developed PCK, knowledge of learners, CK, and curricular knowledge contribute to effective selection and use of instructional videos, while TK is less important.

Through careful coding and analysis of the data, four types of knowledge emerged as particularly impactful when teachers made decisions about the selection and use of instructional videos; PCK, knowledge of learners, CK, and curricular knowledge. While untangling and separating teacher knowledge types is “is an analytic act and one that is difficult to tease out in practice” (Mishra & Koehler, 2006, p. 1029), this process allows us to identify areas future teacher development can be focused.

Importantly, a teacher’s effective use of instructional videos had little to do with their TK. Indeed some of the teachers who self-reported higher technological proficiency displayed less nuanced and purposeful integration of videos in their teaching. This may have been because none of the nine teachers in this study used particularly emerging technology to display or share the videos with their students. For example, none of the teachers interpolated activities into the videos they played, used interaction statistics to measure engagements, or used video annotation tools. In a different context in which such technologies were used or expected, TK may have emerged as a more important predictor of effective use.

Rather, this study revealed that effective selection and use of instructional videos draws most heavily on PCK, knowledge of learners, CK, and curricular knowledge, and the development of these knowledge types was correlated with more nuanced and effective use. This suggests that instructional videos, at least in the way the teachers in this study used them, do not constitute the kind of technology that fundamentally changes teaching practice but instead that they are considered part of an “armamentarium” (Shulman, 1987, p. 9) of teaching resources. The impact of each these four knowledge types are briefly outlined below.

(a) *PCK allows teachers to contextualise videos, and leads to the incorporation of videos into meaningful learning sequences.*

The videos teachers used in their classes were rarely perfectly aligned with the curriculum demands and teaching goals of the teacher. Because of this, teachers largely used

PCK to introduce the purpose of the videos, add explanations, deal with student misconceptions, and bridge the gap between prior learning and the video content.

Differences in PCK development were most noticeably recognised in the ways in which various teachers incorporated videos into learning sequences. In this study, teachers lacking experience in teaching a particular topic tended to show videos in isolation perhaps with a related comprehension activity or discussion. Teachers with more experience tended to use videos in complex teaching sequences drawing on an understanding of the particular affordances of video, the needs of their particular students, and the interaction of videos with other pedagogical actions. Examples include interrogating the videos as historical documents following a creative hypothetical activity in a History class (Dennis); using a combination of a declarative video, guided discussion, and individual how-to videos in an Art class (Lucy); and combining a declarative video watched on individual devices with one-on-one teacher interaction and data collection for future analysis in a Science class (Helen).

The teachers in this study recognised that videos were more effective at conveying some topics than others: in particular declarative content, human emotion, and procedural-motor tasks. This echoes Koehler et al.'s (2013) suggestion that "particular technologies have their own propensities, potentials, affordances, and constraints that make them more suitable for certain tasks than others" (p. 14).

(b) *Knowledge of learners contextualises teacher selection and use of instructional videos in ways CLT/CTML does not account for.*

The teachers in this study recognised that they taught their classes to particular learners and that doing so required knowledge of student preferences, culture, and prior learning. A common theme was that students enjoyed watching videos particularly when the content was considered boring or as a way of achieving pedagogical variety. However, students only engaged with those that were not considered *corny* or *cringe-worthy*. The teachers had a tacit understanding of the ICALM (see Section 3.5) in that they recognised video content had the power to stimulate positive cognitive-affective states like interest or, alternatively, negative ones like boredom or cringe. Furthermore, it emerged that what was considered cool by students differed across schools and between age groups. Experimental research into affective influences of multimedia (Plass et al., 2014; Uzun & Yıldırım, 2018) has so far attributed affective change in students to factors internal to the media, such as colour and shape, but failed to consider external factors such as learner culture or classroom dynamics. This research challenges the previous narrow view of emotional design.

(c) CK acts as quality control, and empowers teachers to teach beyond the video

Content knowledge emerged as an important tool for fact checking videos found on YouTube. In short, teachers with well-developed CK who watched videos prior to showing them to students reported comparing them to their own pre-existing CK at a substantive and syntactic level (Shulman, 1986). In contrast, Alison and Troy reported using videos when their CK was lacking in order to make up for their lack of confidence with the subject matter. In particular, Alison chose “the first one that came up” in a YouTube search to teach a topic that was “completely new” (I2). More research is needed to investigate the prevalence of video use by early career and out-of-field teachers to cover for a lack of CK, particularly from user-generated platforms which operate without editorial oversight.

During instruction, CK also empowered teachers to add instruction beyond the content of the video, meaning that they were able to answer student questions about material related to, but beyond the scope of the video. Again, the lack of such knowledge restricted a teacher's ability to use instructional videos as a provocation for discussion or further inquiry. This lends support to Shulman's (1986) argument that CK is central to a teacher's ability, and that it cannot be compensated for through a focus on PK alone.

8.1.3 Hierarchical curricular knowledge

Curricular knowledge exists in a hierarchy, determining content and facilitating selection.

Curricular knowledge consists of knowledge about mandated curriculum documents at a state and local level; textbooks; and other curricular materials. It also includes knowledge about how and when to select these materials. The teachers in this study understood these types of knowledge in a hierarchy in which instructional videos were used when they: a) presented materials consistent with the mandated curriculum, and b) complimented official textbooks by either presenting material in a more engaging manner, or adding material that was "relatively scant" (Dennis, I2) in the text. This addition of a curricular hierarchy extends Shulman's (1987) conception of curricular knowledge. This study also extends the understanding of curricular knowledge to include search strategies and knowledge about instructional design priorities when selecting from online platforms.

8.1.4 Knowledge and freedom

Teacher knowledge both empowers and bounds teacher practice.

Shulman (1986) saw the development of knowledge as key to empowering effective teaching, freeing teachers to reason through difficult pedagogical scenarios. While well-developed knowledge has been found to lead to effective teaching, multiple examples have also emerged of knowledge providing boundaries to teacher action, rather than “guaranteeing freedom” (Shulman, 1986, p. 13). Knowledge of mandated curriculum bounded video subject matter; knowledge of student culture prevented teachers from using “corny” videos; and knowledge of the school culture prevented Helen from using a potentially controversial video. This study suggests that teacher knowledge provides the freedom to reason pedagogically, but only within particular boundaries.

8.2 Videos in context

This section outlines six findings related to the ways in which teaching contexts impact on teacher selection and use of instructional videos. The contextual framework proposed by proposed by Porras-Hernández and Salinas-Amescua (2013) and extended by Rosenberg and Koehler (2015a) was used to analyse the impact contextual factors had on teacher enaction of knowledge. At the micro level, teachers chose to use the classroom projector technology rather than student devices. This drew on some of the affordances of instructional videos outlined in Section 3.1.4 such as using them as prompts for class discussion (McNeill, 2009; Murray, 2009; Tan & Pearce, 2011) but stood in apparent contrast to the CLT/CTML principle of learner control. At the meso level, teachers were found to select and plan for the use of videos in isolation, rather than as part of teaching teams. Further, teacher perceptions of time-poverty often impaired their ability to enact what they saw as best practice. At the macro level, YouTube and the algorithms that drive the platform were found to be entwined with teacher selection and use of videos, and this is explored. These findings are followed by discussion of three implications for teacher professional practice and training.

8.2.1 Working in isolation

Teachers select and use videos in isolation rather than in collaboration with colleagues.

Despite initial claims by several of the teachers that videos were widely shared with colleagues, amongst the nine participants in this study only 6 of the 58 videos used were sourced or planned collaboratively, meaning the selection and use of instructional videos was overwhelmingly an individual labour. This reality means not only that teachers replicate labour in a time-poor environment but that they do not draw on the collective wisdom of practice, meaning less experienced teachers are not able to learn from their more experienced colleagues. Shulman's (1987) claim that teaching suffers from a "collective amnesia, the consistency with which the best creations of its practitioners are lost" (p. 11) remains true with regard to the use of instructional videos.

8.2.2 Time poverty and video use

Teachers' perception of being time-poor impairs their ability to select and use videos in optimal ways

The participants considered themselves time-poor, and cited this lack of time, rather than knowledge, as the key reason for failing to perform what they considered optimal pedagogical actions with videos. The particular tasks teachers chose not to perform varied between participants, supporting the findings of Philipp and Kunter (2013) that teachers often select between the myriad tasks expected of them, channelling efforts into those activities considered important or interesting, and avoiding what is considered less important or too draining on resources. The tasks avoided included rigorous fact checking (Carl, Helen, and Troy), bespoke video creation (Lucy and Alison), and creating enhanced videos (Dennis). For Alison, even the process of searching for videos was deemed too time-consuming when she knew the content well. In these instances, lack of knowledge was not the key barrier to optimal selection and use of instructional videos, but perceived lack of time.

8.2.3 Projectors not devices

Teachers display most videos on communal projectors rather than individual devices.

Despite research suggesting that learner control over playback controls improves learning outcomes, this study found that most (51 of 58) videos were shown to students on a communal projector, with the teacher controlling playback. Reasons given for this ranged from classroom management (Alison, Carl, and Louise), to timing of lessons (Melissa), and allowing for contextualisation, clarification, and discussion (Dennis, Margaret, Melissa, Troy, and Lucy). In short, the micro-contextual realities of the classroom motivated teacher use of instructional videos. This is important because most studies used to determine the design principles outlined in Chapter 3 are conducted in lab conditions with one student at a time protected from distractions, watching a single screen, often with control over playback. The difference between the experimental conditions and the actual conditions in which instructional videos are used in mainstream secondary classes is stark. These important differences problematise the application of laboratory devised CLT/CTML principles to actual classroom practice.

8.2.4 The dominance of YouTube

YouTube is the dominant source of instructional videos used in mainstream classrooms.

Despite its status as a platform supported by advertising revenue and primarily used as a source of entertainment surfacing largely user-generated content (Arthurs et al., 2018), YouTube was the source of the vast majority (50 of 58) of videos used by the teachers. This is important because content on YouTube is rarely subject to editorial control (Mohammed, 2019; Landrum, 2019) and the search algorithm has been shown to preference controversial content (Rieder et al., 2016). Selecting factually accurate and appropriate videos from YouTube relies not only on well-developed teacher knowledge, but also requires time to be spent carefully evaluating videos. This was revealed as a time-consuming task that not all teachers prioritised. This dominance of YouTube has implications for the two following findings.

8.2.5 Search and Scroll – an uncritical method

Teachers often use a search and scroll technique to find videos.

When searching on YouTube the most common search strategy used could be termed 'search and scroll'. This describes the practice of entering a small number of keywords into YouTube's search bar and then scrolling through the result list to find a video that seems to satisfy the teacher's aim. While some teachers searched critically through the video sources they were offered, others were less critical, even showing videos to students they had not viewed themselves. YouTube is run by search and recommender algorithms that influence the kind of content that is surfaced in searches and that teachers eventually select. This human-software entanglement (Edwards, 2015) remains an understudied and under-theorised aspect of teacher practice. Effective search strategies emerged as a new type of curricular knowledge but one that few of the teachers had developed effectively.

8.2.6 TPACK and false transparencies

Algorithmic platforms like YouTube are falsely transparent technologies.

In the TPACK framework, transparent technologies are those whose use has “become commonplace” (Mishra & Koehler, 2006, p. 1023) and in the use of such TK is backgrounded. Cox (2008) extended this understanding by suggesting a sliding scale from emerging to transparent and “as particular technologies become ubiquitous in the classroom, the focus on those technologies is no longer necessary” (p. 99). This study challenges the dichotomy of transparent and emerging technologies proposing instead the existence of *false transparencies*. Algorithmic technologies like YouTube are necessarily “black boxed” (Bishop, 2018) meaning that due to the nature of AI systems and commercial priorities the exact workings of algorithms remain hidden. Because of this, such technologies can never truly be understood by users, or be made ‘transparent’. Algorithmic platforms like YouTube that become ubiquitous may be better described as falsely transparent in that teachers take them for granted (Edwards, 2015) but are unaware of the impact the algorithm is having both on the content surfaced or on the design decisions of the content producers.

8.3 Implications for practice

This study adopted as a research paradigm Selwyn’s (2008) call for literature that addresses the state-of-the-actual concerning educational technology rather than the state-of-the-art. As such, this research is able to present implications for the improvement of teaching with instructional videos that is sensitive to the real contexts in which teachers labour. Table 15 presents five practical implications focused on improving teacher education and practice, and these are discussed below.

Table 15:

Implications for Teacher Education and Practice

Theme	Practical implication
Effective video design in teacher training	Initial teacher training programs should include an introduction to research into effective design and use of videos as described in Chapter 3.
Educational scholarship	Educational scholarship on instructional video design needs to be made more accessible to teachers
Collaboration	Within schools, teachers should be encouraged to work collaboratively when selecting videos and planning for their use
The role of CLT/CTML	CTML/CLT principles should be presented to teachers as considerations, rather than 'evidence-based prescriptions'
Algorithmic awareness	Teachers should become aware of the influence of algorithmic platforms on their labour.

Practical implication 1: Initial teacher training programs should include an introduction to research into effective design and use of videos as described in Chapter 3.

The participants in this study relied on knowledge derived from their own wisdom of practice. While this generally led to effective use of instructional videos by experienced teachers it meant less experienced teachers were left to learn "the hard way" (Troy, I2) through trial and error. It also meant that when making decisions as to which tasks to dedicate time to and which to give short shrift, these inexperienced teachers were left without a theoretical basis on which to make those strategic decisions. Such an introduction would at a minimum include the CTML/CLT principles and the various video-based learning pedagogical approaches described in the literature.

Practical Implication 2: Educational scholarship needs to be made more accessible to teachers.

Supporting earlier findings (Booher et al., 2020; Duncan-Howell, 2010; Maclellan, 2016), this research suggests that there is a divide between the output of educational researchers and teaching practitioners. That not one of the nine teachers in this study was aware of any research into instructional video design suggests that more needs to be done to communicate educational research to teachers, particularly with regard to instructional design.

Practical Implication 3: Within schools, teachers should be encouraged to work collaboratively when selecting videos and planning for their use.

This research found that teachers largely selected and planned with videos in isolation despite this labour often being time-consuming and frustrating. Furthermore, while younger teachers like Carl may suggest that it is the older teachers who "struggle with technology" (I1), it was those experienced teachers who more often demonstrated nuanced and arguably more effective use of videos. In order to provide opportunities for apprenticeship and to avoid the collective amnesia lamented by Shulman (1987), teachers would benefit from planning the use of videos collaboratively and recording this planning in curriculum documentation.

Practical Implication 4: CTML/CLT principles should be presented to teachers as considerations rather than "evidence-based prescriptions".

Design and use principles established in experimental settings, such as those in the CLT/CTML literature are often presented to educators as prescriptive truths (Brame, 2016; Clark & Mayer, 2016). Instead, this study suggests that teachers regularly have pedagogically reasonable justifications for practices that at least initially seem to violate these principles. For example, the choice to deny learner control of playback, while a violation of much of the literature, was seen as a way of facilitating discussion, bridging content, and monitoring student understanding – factors that are rarely considered in experimental designs. In addition, the teachers recognised a tension between entertainment and content delivery because, as Helen so deftly put it “[the students are] more likely to learn something from it if they're not falling asleep on the back table” (I2). This stands in contrast to the attention demanded in a laboratory study. Because of this, communication of these findings to practitioners should be presented as considerations rather than prescriptions thus honouring the teacher’s knowledge of their own learners and context, and acknowledging the contextual differences between the classroom and the laboratory.

Practical Implication 5: Teachers should become aware of the influence of algorithmic platforms on their labour.

The search and scroll practices of teachers when using YouTube suggested they may have accepted what Bishop (2018) called “the myth of platform objectivity” (p. 77). As this study reveals, teachers may be better served by a more informed and critical approach to algorithmic systems, allowing them to consider the potential impact those systems can have on both the content available and the results surfaced by searches. While such training could be introduced into initial teacher training courses, it is of enough importance that ways need to be found to also allow in-service teachers to investigate algorithmic influence.

8.4 Implications for future research

Given the limitations of this research and the emerging status of research into instructional videos in the light of algorithmic platforms, there are at least seven clear avenues for further research.

Research direction 1: Replicate CTML/CLT studies in real educational contexts.

While the CTML/CLT principles emerging largely out of experimental designs are useful as a basis for video design, this research suggests that there are contextual factors present in classrooms that threaten their rigid application to real learning environments. For example, while studies on learner control have established that students learn better when they control playback, researchers have rarely considered the role of classroom distractions or motivation levels. A novel approach to this questionable external validity was taken by Merkt et al. (2011) who replicated their experimental study of various levels of video interactivity in a quasi-experimental secondary school setting. Such complementary replications of design principles in authentic educational contexts could help build trustworthiness in established design principles and define boundary conditions (Butcher, 2014).

Research direction 2: Replicate CTML/CLT studies in real educational contexts.

This thesis found that in some instances teacher knowledge bounds practice rather than offering freedom as suggested by Shulman (1986). While knowledge has been shown to lead to more effective pedagogical reasoning (Loughran et al., 2016), further research could be conducted into whether teachers with more developed knowledge feel empowered or constrained. This phenomenological research may reveal important insights into the conditions under which experienced vs inexperienced teachers develop new pedagogical practices, take risks, and perceive developments.

Research direction 3: Investigate and theorise the role of video in portraying human emotion.

Research is needed into the role of instructional videos to convey instructionally pertinent human emotions. This study revealed that a key affordance of instructional videos for teachers of History was to convey the human emotions of historical actors, such as Fidel Castro (Dennis) and victims of lynching (Melissa). As yet, the systematic review conducted for this study revealed most research into effective instructional design has focused on declarative content, largely in STEM domains. Humanities subjects may rely more on empathy and communication of emotion and as such an exploration of how design can best communicate emotion may be beneficial.

Research direction 4: Apply the ICALM theoretical framework to student cultural perceptions of instructional videos.

There is an unexplored research pathway into how student perceptions of the cultural appeal of videos affects learning outcomes. The teachers in this study reported that student culture was an important factor in how a video would be received by students. In short, videos that the participants thought were corny or cringeworthy appeared to reduce student engagement in learning while videos considered cool were believed to increase student attention. Consistent with the ICALM (see Section 3.5), student perception of the appeal of videos may moderate cognitive-affective states and therefore impact learning outcomes. Furthermore, the particular aspects of videos like stereotypes and style leading to “emotional responses that interfere with cognitive processing” (Plass & Kaplan, 2016, p. 151) may differ between students and cultures, casting doubt on whether some principles of design, particularly with regard to emotional design, can be applied universally. As yet, this relationship between culture and video design has not been explored.

Research direction 5: Investigate the impact of the YouTube algorithms on educational content producers.

Research exploring the impact of the YouTube algorithms on educational content producers may shed further light on the nature of the human software entanglement (Edwards, 2015) involved in the use of YouTube videos in classrooms. This thesis has argued that because teachers tend to use a simple search and scroll technique when finding videos on YouTube, the algorithm impacts the videos teachers see and therefore those from which they choose. Recent research suggests that content producers pay close attention to the algorithm in order to boost watch time and revenue (Bishop, 2020; Wu et al., 2019). So far none of this research has focused on educational content producers and as such the extent to which educational videos are produced with a focus on satisfying the algorithm is unknown.

Research direction 6: Reliability studies of YouTube content.

Given that the less experienced teachers in this sample at times relied on YouTube as a source of information on the topics they were called to teach, there is a need for studies examining the reliability of the content surfaced by YouTube. Such studies are commonplace in medicine (Okagbue et al., 2020) because misinformation can be particularly harmful to patients.

A similar argument could be made that misinformation in supposedly educational videos could be considered harmful.

Research direction 7: Studies into the impact of professional learning on teacher selection and use of instructional videos.

This study found that most videos chosen by teachers were done so in isolation, and that the principle source of knowledge about video design and use was wisdom of practice. To inform providers of professional development, both in schools and in tertiary training institutions, studies are needed to measure the actual impact of various professional development programs on teacher practices. In particular if given a wider perspective on design principles such as those described in this thesis, would teachers actually change their practices, and to what extent would contextual factors of time and knowledge of individual students continue to mediate this selection? Furthermore, it would be of interest to investigate whether collaborative, ongoing professional learning programs such as those advocated by Henderson (2007) would lead to more collaborative selection and planning with instructional videos.

This list is by no means exhaustive but is an indication that instructional video use in mainstream educational contexts is an immature field of inquiry rich in research opportunities. In particular, the role of algorithmic platforms and human-software entanglement in the development and use of curricular materials is arguably of growing importance to educators and policy makers. The lack of empirical and theoretical work in this area suggests this should be a research priority in the near future.

8.5 Concluding statements

This thesis has addressed gaps in the research literature. Based on an extensive literature review, this is the only case study examining ways in which teachers in mainstream secondary schools in Australia select and use instructional videos. With a focus on teacher knowledge and context in this process (the only such work in the literature), this thesis has made ten theoretical or empirical propositions, suggested five implications for practice, and proposed seven future research directions.

This research furthers a discussion into the ways in which algorithmic systems are entangled with the labour of teaching. This is a reality that may emerge as particularly important in future work. Furthermore, this thesis problematises the ways in which experimental literature can be applied to classroom contexts. Finally, this thesis confirms Shulman's 1986 suggestion that teacher knowledge, particularly that derived from the wisdom of practice, is central to effective teaching.

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Appendices

Appendix A – Video Type Nomenclature in the Literature

Video type	**Chorianopoulos (2018)**	**Guo et al. (2014)**	**Winslett, 2014**	**Poquet et al., 2018**	**Chen & Wu, 2015**	**Santos-Espino et al. 2016**	**Hansch et al 2015**	**Choe et al., 2019**
Lecture capture	instructor	talking head	presenting to the camera: explanations, instructions and stories		lecture capture format	live lecture	Classroom Lecture	Classic Classroom
	instructor with audience	classroom lecture	recording and transmitting a teaching event					
Picture in picture superimposed	Talking Head superimposed				picture in picture (superimposed)	talking head	Text-Overlay	Weatherman
							Green Screen	
picture in picture live shot/webcam	Talking head live shot				voice over type	head and slides	Picture in picture	Talking head
	Talking head small webcam							Slides on/off
Voice over slides	slides	PowerPoint slide presentations				slides	Presentation Slides with Voice-Over	
Khan style	pentip	digital tablet drawing format				virtual whiteboard	Khan Style Tablet Capture	Pen Tablet
Animated declarative	animated human		Simulating, modelling or capturing hard to see processes and contexts				Animation	
Live action how-to	talking head instrument; people instruments		Simulating, modelling or capturing hard to see processes and contexts					
Whiteboard animation	hand					virtual whiteboard	Udacity style Tablet Capture	
Lightboard lesson								Learning Glass
Documentary style						documentary		
Interview/Vox Pop			Interviews, testimonials and vox pops			interview dialogic	Conversation	Interview
						interview declarative	interview	
Worked Example	Talking head small webcam		producing video games	Worked Examples (eg tutorials, code-along videos)		screencast	Screencast	
Infotainment Combined								

Dramatisation	dramatic works: dramatising stylising or modelling real life practices		
Live Capture	fly on the wall: capturing real life practices and contexts	Demonstration	Demo
		On Location	
Combination	mashing up: manipulating, re-using & modifying existing video materials		

Appendix B - Overview of literature included in systematic review

The following three tables outline the coding structure for the systematic review referred to in Chapter 3 and the findings of that coding.

Coding Structure

Variable	Description	Scoring criteria
Method	Methodology used to collect data	EX - Experiment QE - Quasi Experiment CS - Case Study MM - Mixed Method
Video Type	Style of video used	AD - Animated Declarative AHT - Animated how-to AR - Animated recreation of real events DOC - Documentary Style DRA - Dramatisation ID - Interview or Dialogue LC - Lecture Capture LB - Lightboard LHT - Live action how-to LCR - Live capture of real event NT - Narrated Tablet (Khan style) PIP - Picture in picture TH - Talking Head VS - Voice over slides WE - Worked examples COM - Combination V - Various U - Unsatisfactorily Described
Duration	Duration of video in seconds	Include in seconds if reported exactly Include with * if reported approximately Include multiple if up to three videos used eg. 32/210/250 V – Variety (if over three videos used) NS – Not Specified
Topic	Main instructional topic of the video/s	Included as reported
Domain	Main instructional domain of video/s	STEM - Science, Technology, Engineering, Mathematics PM - Practical/Manual ART - Artistic HUM - Humanities DRV - Driving TT - Teacher Training COM - Communications SPO - Sport M – Multiple

Learner Control (LC)	Degree to which learners had control over the playback of the video. Multiple reported when learner control is the principle of research	S - System or instructor paced FS - Full Scrubbing control PP - Pause Play control LCI - Learner Controlled Instructional Order CC - Continue Control MV - Multiple View Control NS - Not Specified
Display	Screen type used to show the video to learners	IND - Individual Screen PRO - Projector or Communal screen SO - Student own Device, uncontrolled SGS - Small Group Screen NS - Not Specified or unclear
Population (n=)	Number of participants in total	Number reported or NA if no participants (eg. Existing data analysis)
Age/Context	The learning context or level in which research took place	PRIM - Primary SEC - Secondary TER - Tertiary (conventional) MOOC - MOOC style tertiary AD - Adult PRO - Professional UN - Broad or Undefined
Principles	Principles for which findings were reported	See Table below, column one for number and description of each principle
Recall (R)	Recall performance of learners reported	If recall findings reported include *, if not, leave blank
Transfer (T)	Transfer performance of learners reported	If transfer findings reported include *, if not, leave blank
Proficiency (P)	Proficiency performance of learners reported	If proficiency findings reported include *, if not, leave blank
Effect Size	Effect size reported	If effect size(s) reported, include *, if not, leave blank

Descriptions and counts of design principles

	Extraneous Processing Principles	**Description of design technique**	**Total**	**Replicate**	**Fail**
1	Coherence*	Only instructional material directly related to the key learning goal should be included.	10	8	2
2	Signalling*	Important information should be highlighted to learners	13	10	6
3	Redundancy*	Written text should not be added when narration is present	13	5	8
4	Spatial Contiguity*	Related elements should be presented in close physical proximity on the screen (also called split attention)	3	3	0

5	Temporal Contiguity*	Related elements (eg. narration and visuals) should be presented at the same time	0	0	0
6	Segmenting*	Longer videos should be broken into meaningful chunks	12	10	2
7	Background music	Avoid including distracting background music	3	2	2
8	Audio Quality	Audio should be clear, with no distracting hissing or interference	2	2	1
9	Video Length Reduction	Shorter videos are more effective than long ones	11	11	2
10	Perspective (1st superior)	Videos shot from the learner’s perspective are more effective than third person perspective	1	1	0
11	Presenter’s face	Avoid including the presenter’s face when alternative visuals are displayed	7	1	2
12	Sound Effects	Avoid including sound effects	1	1	1
	Essential Processing Principles				
13	Pre-Training*	Learner’s should be introduced to key names and characteristics before the lesson	2	2	0
14	Modality*	Use spoken narration rather than written text	12	6	8
15	Multimedia*	Use words and pictures rather than words alone	2	2	0
16	Speech Rate (Fast superior)	Speech rate should be faster than conversational speaking rate	2	2	1
17	Transience	Video loses advantages over static media when too much information is presented too quickly	6	4	3
18	Worked Example	Include completed guidance/examples when solving problems/learning skills	3	2	1
19	Learner Control	Students should be given control over playback	17	12	3
20	Reviews	Videos should end with a summary of the content	3	3	0
	Generative Processing Principles				
21	Personalisation*	Narrations should use first/second person conversational speech	7	5	3
22	Voice Principle*	Narrations should be recorded in a human voice rather than synthesised, machine voice	0	0	0
23	Embodiment Principle*	Videos should include human movement/gestures, such as showing hands when assembling	10	8	3
24	Guided Discovery*	Interface should provide hints and feedback as learner solves problems	1	0	1
25	Self-Explanation*	Videos should prompt students to explain the learning goal to themselves	4	2	2
26	Drawing*	Leaners should be encouraged to draw the learning goals	0	0	0
27	Dialogue	Videos that show dialogue between an instructor and learner outperform straight declarative videos	2	2	0
28	Emotional Design	Warm, high saturation colours and anthropomorphisms should be used in videos	4	3	3
29	Misconceptions	Conceptual videos should dispel common misconceptions at the start	2	2	0
30	Integrated Learning Activities	Integrate practice activities, either during pauses in the presentation or following the video	6	6	0
31	Interactivity	Videos that include learner controllable content outperform standard playable video	4	3	1

List of coded papers

Authors and Year	Method	Video Type	Duration (sec)	Topic	Domain	LC	Display	n=	Age/ Context	Principles	R	T	P	ES
Adegoke, (2010)	QE	U	NS	Physics	STEM	S	PRO	517	SEC	3	*	*		*
Ali (2010)	QE	AD	20*	Celular signal transmission	STEM	S	PRO	124	TER	6	*			
Ali (2013)	QE	AD	27*	Celular signal transmission	STEM	S	PRO	124	TER	6	*			*
Arnone and Grabowski (1992)	EX	AD	NS	Ceramics, sculpture, painting	ART	LCI	PRO	101	PRIM	19	*			*
Austin (2009)	EX	AD	NS	Lightning	STEM	NS	IND	404	TER	3, 4, 14		*		
Barnes (2016)	QE	AD	45	Dust storms	STEM	PP	IND	135	TER	32	*			
Biard, Cojean, and Jamet (2018)	EX	LHT	312	Hand orthoses	STEM	S/PP	IND	68	TER	6, 19	*		*	
Bobrow et al. (2011)	EX	LHT	60/300	Emergency CPR	PM	S	PRO	336	AD	9			*	
Boucheix and Forestier (2017)	EX	AHT/LHT	23/29/32	Nautical knots	PM	MV	IND	206	PRIM	17			*	*
Boucheix and Guignard (2005)	EX	AD	100/250	Gearing systems	STEM	S/CC	IND	123	PRIM	2, 17, 19	**	*		
Castro-Alonso, Ayres, and Paas (2015)	EX	LHT	92	Lego task	PM	S	IND	172	TER	23			*	
Chang (2017)	EX	WE	NS	Buoyancy	STEM	PP	IND	62/66	SEC	6, 24, 31		*		
Chen and Wu (2015)	EX	LC/PIP	900*	Document writing	HUM	NS	IND	37	TER	4, 21, 23, 11	*	*		
Chen (2016)	EX	WE	437	Adobe Illustrator	ART	FS/MV	IND	120	TER	14, 17, 19	*	*		
Cheon et al. (2014)	EX	AD	160	Lightning	STEM	S	IND	99	TER	30	*	*		*
Cheon, Crooks, and Chung (2014)	EX	AD	160	Lightning	STEM	CC	IND	96	TER	6, 14, 30	*	*		
Chien and Chang (2012)	EX	AD	NS	Using an Abney Level	PM	FS	IND	27	SEC	31			*	*
Chung, Cheon, and Lee (2015)	EX	AD	40	Lightning	STEM	S	SO	206	TER	14	*			*
Cook et al. (2016)	EX	WE	NS	Mathematics	STEM	NS	IND	65	PRIM	23		*	*	
Cooper and Higgins (2015)	QE	U	V (55-118)	Joint rehabilitation	STEM	FS	SO	98	TER	9			*	*
De Boer, Kommers, and De Brock (2011)	EX	U	V (53-210)	Photography equipment	STEM	FS	IND	50	TER	19				

de Koning, Tabbers, Rikers, and Paas (2007)	EX	AD	60	Cardiovascular system	STEM	NS	IND	40	TER	2	*	*		*
de Koning, Tabbers, Rikers, and Paas (2010)	EX	AD	132	Cardiovascular system	STEM	S	IND	40	TER	2	*	*		
de Koning, Tabbers, Rikers, and Paas (2011)	EX	AD	305	Cardiovascular system	STEM	S	IND	90	SEC	2, 25	*			
de Koning, van Hooijdonk, and Lagerwerf (2017)	EX	AHT	84	Patient transfer	PM	FS	IND	129	TER	3, 14	*		*	
Debuse, Hede, and Lawley (2009)	EX	PIP	1800*	Scholarly referencing	HUM	FS	SO	48	TER	3	*			
Delen, Liew, and Willson (2014)	EX	DOC	960*	Renewable energy	STEM	FS	IND	80	TER	25, 31	*			*
Dousay (2016)	QE	AD	NS	Driver safety	DRV	FS	SO	102	PRO	14				
Dunsworth and Atkinson (2007)	EX	AD	V (203-345)	Cardiovascular system	STEM	CC	IND	51	TER	14, 23	*	*		*
Fanguy, Costley, Baldwin, Lange, & Wang (2019)	QE	PIP	NS	Scientific Writing	STEM	FS	SO	110	TER	4	*			
Fiorella and Mayer (2016) (2)	EX	LC/NT/VS	100*	Doppler effect	STEM	S	IND	157	TER	23, 2	*	*		*
Fiorella, van Gog, Hoogerheide, and Mayer (2017)	EX	LHT	82/90	Electronic circuits	STEM	CC	IND	226	TER	10			*	*
Fountoukidou, Ham, Matzat, & Midden (2019)	EX	AHT	NS	Eye controlled web search	STEM	NS	NS	197	AD	23				*
Garcia-Rodicio (2014)	EX	AD	400	Plate tectonics	STEM	CC	IND	97	TER	20, 25, 30, 31	*	*		*
Garland and Sanchez (2013)	EX	LHT	30*	Knots	PM	FS	IND	86	TER	32			*	
Giannakos, Jaccheri, and Krogstie (2016)	CS	LC	V (2400-3000)	Software engineering	STEM	FS	SO	40	TER					
Guo, Kim, & Rubin (2014)	MM	V	V	Programming, Chemistry, Statistics, AI	STEM	FS	SO	NA	MOOC	1, 6, 9, 11, 16, 19, 21				
Hasler, Kersten, and Sweller (2007)	EX	AD	225	Earth rotation	STEM	S/CC/PP	IND	72	PRIM	19	*			*
Hatsidimitris and Kalyuga (2013)	EX	AHT	90	Writing Chinese characters	ART	FS	IND	68	TER	19	*		*	*
Herala, Knutas, Vanhala, and Kasurinen (2017)	CS	LC	V (2700-3600)	Software engineering	STEM	FS	IND	144	TER	9, 21				
Hoffler and Schwartz (2011)	EX	AD	73	Surfactants	STEM	S/FS	IND	82	SEC	19	*	*		
Ibrahim, Antonenko, Greenwood, and Wheeler (2012)	QE	DOC	1920	Insects	STEM	S	PRO	226	TER	1, 2, 6	*	*		*
Ibrahim, Callaway, and Bell (2014)	QE	U	NS	TPACK	TT	FS	SO	156	TER	2, 6	*	*		*
Izmirli and Kurt (2016)	QE	U	1314	Computer science	STEM	MV/LCI	IND	97	TER	14, 19	* *			

Jadin, Gruber, and Batinic (2009)	EX	PIP	1500*	Industrial economic history	HUM	FS	IND	28	TER	3	*			
Jung, Kim, and Na (2016)	QE	LHT	NS	Car tire replacement	PM	PP	SO	92	TER	3, 13	*			
Kay and Edwards (2012)	QE	NT/WE	141/314/449	Mathematics	STEM	FS	IND	136	SEC	18	*			*
Kim, et al. (2014)	MM	V	V	Programming, Chemistry, Statistics, AI	STEM	FS	SO	NA	MOOC	9				
Kizilcec, Bailenson, and Gomez (2015)	QE	PIP/VS	V (320-1200)	Sociology	HUM	FS	SO	12468	MOOC	11	* *	*		
Kopiez, Platz, and Wolf (2013)	EX	DOC	270	Toxins in lamps	STEM	NS	SO	441	AD	7	*			
Kühl, Eitel, Damnik, and Körndle (2014)	EX	AD*	122	Lightning	STEM	S/FS	IND	79	TER	8, 19	*	*		
Kulgemeyer (2018)	QE	LC	271/286	Cars aquaplaning	STEM	S	NS	176	SEC	1, 20	*	*		*
Langworthy (2017)	CS	LC	V (300-480)	Issues facing young people	TT	FS	SO	NA	UN	9				
Laws et al. (2015)	QE	COM	360*	Newton's laws	STEM	FS	SO	565	TER	31	* *	*		
Leahy and Sweller (2016)	EX	VS	663	Contour maps	HUM	S	NS	71	SEC	14, 17		*		
Lee and Lang (2015)	EX	DOC	3600	News program	M	S	IND	288	TER	3	*			
Lin, Atkinson, Savenye, and Nelson (2016)	QE	AD	NS	Cardiovascular system	STEM	MV	IND	126	TER	2	*			*
Lin, Shen, and Liu (2015)	EX	AD	NS	Heat transfer	STEM	FS	IND	192	PRIM	3, 14, 25, 19	*	*		
Lynch, Barr, and Oprescu (2012)	QE	LHT	V (<120)	Paramedic skills	STEM	FS	SO	87	TER	9, 23				
Marcus, Cleary, Wong, and Ayers (2013)	EX	LHT	69/97	Knot tying	PM	S	IND	36	TER	23	*		*	
Mautone and Mayer (2001)	EX	AD	230	Aeroplane lift	STEM	S	IND	86	TER	2	*	*		*
Mayer and Chandler (2001)	EX	AD	140	Lightning	STEM	CC	IND	29	TER	19	*	*		
Mayer, Fennell, Farmer, and Campbell (2004)	EX	AD	60*	Respiratory system	STEM	S	IND	121	TER	21	*	*		*
Mayer, Griffith, Jurkowitz, and Rothman (2008)	EX	AD	360	Immunology	STEM	S	IND	89	TER	1	*	*		*
Mayer, Heiser, and Lonn (2001)	EX	AD	140	Lightning	STEM	S	IND	78	TER	1, 3	*	*		
Mayer, Mathias, and Wetzell (2002)	EX	AD	45	Braking system	STEM	S	IND	67	TER	13	*	*		
Merkt, Ballmann, Felfeli, and Schwan (2018)	EX	DOC	773	Accoustic oscillations	STEM	S	NS	71	AD	6	*	*		*

Merkt, Weigand, Heier, and Schwan (2011)	MM	DOC	984	Post-war German society	HUM	FS	IND	212	SEC	19	*	*		
Moreno (2007)	EX	DRA/LC	1200*	Pedagogy	TT	S/CC	IND	75	TER	2, 6, 17	*	*		*
Moreno and Mayer (2000)	EX	AD*	180	Lightning	STEM	S	IND	294	TER	7, 12	*	*		*
Moreno and Ortegano-Layne (2008)	EX	AR/LCR	900	Pedagogy	TT	NS	IND	80	TER	32		*		
Muller, Bewes, Sharma, and Reimann (2008)	QE	COM	420*	Newton's laws	STEM	NS	SO	137	TER	27, 29	*	*		*
Muller, Sharma, and Reimann (2008)	QE	COM/ID	V (420-690)	Newton's laws	STEM	FS	SO	678	TER	27, 29	*	*		*
Murray, Koziniec, and McGill (2015)	CS	NT/PIP/EW	V	IT server environments	STEM	FS	SO	85	TER	9, 11, 19				
Ouwehand, van Gog, and Paas (2015)	EX	PIP	120	Mathematical problem solving	STEM	S	IND	35	TER	11			*	*
Ozdemir and Doolittle (2015)	EX	AD*	360	Adobe Flash	STEM	NS	IND	184	TER	1, 3	*	*		
Ozdemir, Izmirli, and Sahin-Izmirli (2016)	EX	EW	NS	Lightning	STEM	FS	SO	109	TER	3			*	*
Park, Knörzer, Plass, and Brünken (2015)	EX	AD	300	Immunisation	STEM	S	IND	101	TER	28	*	*		*
Pi and Hong (2016)	EX	LC/PIP/TH/VS	1500	Attachment	STEM	S	IND	96	TER	9, 11	*	*		
Pi, Hong, and Yang (2017)	EX	PIP	420*	Photoshop	STEM	NS	NS	87	TER	11	*			
Plass et al. (2014)	EX	AD	420	Immunisation	STEM	FS	IND	121	TER	28	*	*		*
Rey and Steib (2013)	EX	AD	V (358-380)	IT networks	STEM	NS	IND	212	SEC	2, 21	*	*		*
Roscoe et al. (2015)	QE	PIP	300*	Writing cohesion	HUM	FS	SO	90	SEC	3	*			
Saecker et al. (2010)	EX	LC	344/453	ADHD	STEM	S	PRO	62	SEC	1	*			
Scheiter et al. (2008)	EX	AD/LCR	302	Mitosis	STEM	S	IND	120	TER	32	*			*
Schittek-Janda et al. (2005)	EX	LHT	371	Surgical hand wash	STEM	FS	IND	28	TER	6	* *		*	
Schmidt-Weigand, Kohnert, and Glowalla (2010)	EX	AD*	206	Lightning	STEM	S	IND	40	TER	14	*	*		*
Schmitz et al. (2018)	QE	ID	900*	Medical bedside manner	COM	NS	SO	114	TER	2			*	
Schroeder, Gladding, Gutmann, and Stelzer (2015)	EX	WE	V (180-240)	Superposition	STEM	FS	IND	88	TER	18	*	*		
Schroeder (2017)	EX	VS	NS	Multimedia learning theory	TT	S	IND	75	TER	21	*			
Schroeder and Traxler (2017)	QE	NT	510	Frictional planes	STEM	FS	IND	99	TER	23	*	*		*

Senchina (2011)	CS	LCR	2100	Human research interactions	COM	S	NS	72	TER	30	*			
Sharma, Alavi, Jermann, and Dillenbourg (2016)	EX	NT	511*	Resting membrane potential	STEM	NS	IND	27	MOOC	2	*			
She and Chen (2009)	EX	AD	NS	Mitosis	STEM	FS	IND	24	SEC	14	* *			*
Shen, McCaughtry, Martin, and Dillon (2006)	QE	LHT	360	Net Games	SPO	S	PRO	240	SEC	1	*	*		*
Shyu and Brown (1992)	EX	LHT	1500*	Origami	PM	FS/MV	IND	52	TER	19			*	
Spanjers, van Gog, wouters, and van Merrienboer (2012)	EX	AD	120*	Probability	STEM	S	IND	161	SEC	6		*		*
Stull, Fiorella, Gainer, and Mayer (2018)	EX	LC/LB	1200	Organic Chemistry	STEM	S	PRO	55	TER	23	*	*		*
Szpunar and Schacter (2014)	EX	LC	1260	Statistics	STEM	S	IND	54	SEC	30	*			
Tabbers and de Koeijer (2010)	EX	AD*	210	Lightning	STEM	LCI	IND	52	TER	19	*	*		*
Tan and Pearce (2011)	CS	V	V	Sociology	HUM	S/FS	SO/PRO	75	TER	8, 7, 9				
Um, Plass, Hayward and Homer (2011)	EX	AD	NS	Immunisation	STEM	NS	IND	118	TER	28	*	*		*
Uzun and Yildirim (2018)	QE	AD	NS	Energy conservation	STEM	FS	IND	106	SEC	28	*	*		
Van der Meij (2017)	EX	WE	V (43-106)	Microsoft Word	STEM	FS	IND	77	PRIM/SEC	20			*	
Van der Zee et al. (2017)	EX	U	420*	Anatomy	STEM	S	SO	125	MOOC	1, 3	*			*
Vural (2013)	QE	U	V (120-300)	PowerPoint 2010	STEM	FS	SO	318	TER	30	*			*
Wong, Leahy, Marcus, and Sweller (2012)	EX	LHT	250	Origami	PM	S	IND	66	PRIM	17			*	*
Yeh, Chen, Hung, and Hwang (2010)	QE	AD	NS	AVL tree data	STEM	FS	IND	244	TER	19	*	*		
Yue and Bjork (2017)	EX	AD	253	Life cycle of stars	STEM	NS	SO	69	UN	1	*	*		
Yue, Bjork, and Bjork (2013)	EX	AD	254/312	Life cycle of stars	STEM	S	IND	107	TER	15, 3	*	*		*
Yung and Paas (2015)	EX	AD	NS	Cardiovascular system	STEM	NS	IND	133	SEC	23	*			*

Appendix C – Systematic review search terms

The following search terms were entered individually into the ProQuest, ERIC, and PsychINFO databases.

(Cognitive Load Theory AND Video; "Cognitive Theory of Multimedia Learning" AND Video; "audio quality" AND (Video OR animation); "Coherence effect" AND (Video* OR animation); "Background Music" AND Video* OR animation; "Seductive Details" AND video* OR animation; split attention AND (video* OR animation); ("attention guiding" OR signalling OR cuing) AND (video* OR animation) AND education; redundancy AND (video* OR animation) AND education; "worked example*" AND (video OR animation); (realism OR first-person) AND (video* OR animation) AND education; modality AND (video* OR animation) AND education NOT game*; ((transient OR transience) AND information) AND (video* OR animation) NOT game*; "video length" OR "video duration AND education*; (("personali*ation effect") OR (personali*ation prinicple))AND (video* OR animation); "pedagogical agent" AND (video OR animation); ("image principle" OR "lecturer* face" OR "presenter* face" OR "image size") AND (video* OR animation); ("image principle" OR "lecturer* face" OR "presenter* face" OR "image size") AND (video* OR animation); "self explanation" AND (video* OR animation); pre-training AND (video* OR animation); "learner control" AND (video* OR animation); (segmented OR segmenting) AND (video* OR animation); "interactive video" AND activities NOT game*)

Appendix D – Ethics approvals

Monash University Human Research Ethics Committee Approval

MONASH University

Monash University Human Research Ethics Committee

Approval Certificate

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project Number: 11676
Project Title: Video goes to school: an evaluation of teacher use of educational videos
Chief Investigator: Dr Michael Phillips
Approval Date: 02/05/2018
Expiry Date: 02/05/2023

Terms of approval - failure to comply with the terms below is in breach of your approval and the *Australian Code for the Responsible Conduct of Research*.

1. The Chief Investigator is responsible for ensuring that permission letters are obtained, if relevant, before any data collection can occur at the specified organisation.
2. Approval is only valid whilst you hold a position at Monash University.
3. It is responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
5. The Explanatory Statement must be on Monash letterhead and the Monash University complaints clause must include your project number.
6. Amendments to approved projects including changes to personnel must not commence without written approval from MHUREC.
7. Annual Report - continued approval of this project is dependent on the submission of an Annual Report.
8. Final Report - should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected completion date.
9. Monitoring - project may be subject to an audit or any other form of monitoring by MUHREC at any time.
10. Retention and storage of data - The Chief Investigator is responsible for the storage and retention of the original data pertaining to the project for a minimum period of five years.

Thank you for your assistance.

Professor Nip Thomson

Chair, MUHREC

CC: Assoc Professor Michael Henderson, Mr Matthew Fyfield

List of approved documents:

Document Type	File Name	Date	Version
Explanatory Statement	Explanatory Statement case studies	21/03/2018	2.1
Consent Form	consent-form Case studies	08/04/2018	2.1
Explanatory Statement	Explanatory Statement case studies	26/04/2018	2.2
Consent Form	consent-form Case studies	26/04/2018	2.2
Supporting Documentation	Sample case study interview schedule	26/04/2018	2.2
Supporting Documentation	Principal letter case studies	26/04/2018	1.1
Supporting Documentation	e-mail to teacher participants	26/04/2018	1.1

Page 1 of 1

Diocese of Sale Catholic Education Ltd Approval

This letter has been redacted to deidentify the school and remove the address of the researcher.

DIOCESE OF SALE
CATHOLIC EDUCATION LTD.

7 June 2018

Mr Matthew Fyfield
[redacted]

Dear Mr Fyfield

Re: Research in the Diocese of Sale

Thank you for your emailed application dated 1 June 2018 in which you have requested permission to conduct a research project entitled *Video Goes to School: An Evaluation of Teacher Use of Educational Videos* involving teachers from [redacted]

Whilst I approve the survey instruments as documented, I do not give consent for you to distribute incentives to teachers in the participating school. Consequently, I request that any reference to this practice is removed from documents before it is distributed.

This *in principle* approval is subject to the attached *Research in Catholic Schools – Standard Conditions*. In particular, please note items three and four which state that participation in the survey must be sought from participants on an *'opt in'* basis. Further, it is a requirement for researchers working on a one-to-one basis with children in schools, to present a current *Working with Children Check* to the school principal.

It is important that you understand that the final permission for you to undertake this work in a Catholic school in the Diocese of Sale rests with the principal.

Should you require further information please contact Mr Richard Wans, Manager: Leadership and Professional Culture via email rwans@ceosale.catholic.edu.au or phone 5614 5107.

With best wishes

Yours sincerely

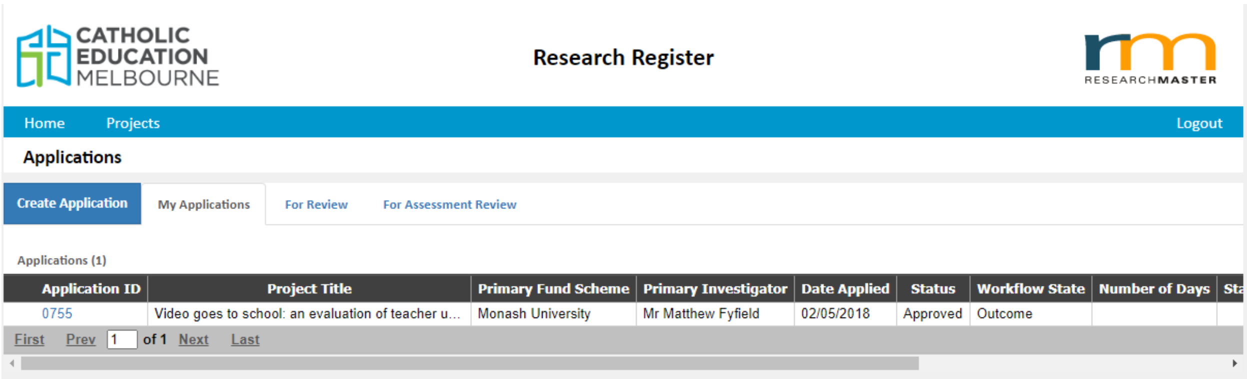
Maria Kirkwood
Director of Catholic Education – Diocese of Sale
Chief Executive Officer – Diocese of Sale Catholic Education Limited

Inspiring Faith, Inspiring Learning

6 Witton Street / PO Box 322 Warragul VIC 3820 - Phone (03) 5622 6600 - Fax (03) 5623 4258 - Email: director@ceosale.catholic.edu.au
ACN 621 266 993 - ABN 91 621 266 993

Catholic Education Office Melbourne Approval

Note that the CEOM does not provide certificates, but instead uses an online research application portal. The following is a screenshot of the approved application


CATHOLIC EDUCATION MELBOURNE

Research Register

RESEARCHMASTER

Home Projects Logout

Applications

Create Application | My Applications | For Review | For Assessment Review

Applications (1)

Application ID	Project Title	Primary Fund Scheme	Primary Investigator	Date Applied	Status	Workflow State	Number of Days	Sta
0755	Video goes to school: an evaluation of teacher u…	Monash University	Mr Matthew Fyfield	02/05/2018	Approved	Outcome		

First Prev 1 of 1 Next Last

Appendix E – Interview schedule

What follows is the outline of the two semi-structured interviews. Given the nature of such interviews, the conversations were guided by this schedule, but often deviated due to participant interest or responses.

Interview 1:
Prior to the interview questions, two statements will be made by the interviewer

1. **An explanation of the purpose of the research and thanks for the teacher's time**
2. **An explanation as to what is meant by the term *instructional video***

This research is focused on investigating the use of instructional videos by secondary teachers like you. Instructional videos are defined as those that either deal with declarative knowledge, meaning "factual and conceptual information" or outline procedural or skills-based knowledge, such as how to use a piece of equipment, how to write a paragraph, or how to search a database.

The similarity between the two is that they concern the transmission of defined knowledge, rather than the fostering of values or application of ideas to new circumstances.

This deliberately excludes other legitimate uses of video in class, such as to motivate students (Abeysekera & Dawson, 2014), challenge student value systems, stimulate inquiry, or provoke discussion of known phenomena. While such uses of videos merit research, they are outside the scope of this project.

Knowledge types	Theme	Questions	Probes
Comprehension	Understanding of concept	Just to show me how clear I've been in trying to define the instructional video idea, could you give me an example of a video you might have used or seen that fits the definition? Where did you find this video? Is that the usual place you would look?	Ask for context in which the video was used. What was the content or procedure taught? Did all students in the class watch the videos? Collect URL (web page address)
Content Knowledge	Introduction of Unit/Sequence	What class did you teach last? What is the topic you are currently teaching, or if you are close to finishing it, what are you teaching next in that class?	Subject – Year level – number of students What do the students get wrong often?

	Syntax Content Knowledge	Considering your own knowledge in this particular topic, how would you rate yourself? At a guess, how many times would you say you have taught the topic before?	If 10 were a university professor and 1 was a complete novice (like one of your students perhaps). Have you studied this topic formally, or learned since you were a teacher?
Pedagogical knowledge Curriculum knowledge/search practices Knowledge of context	Videos	Some might say that there are better things students could be doing with their time than watching instructional videos. Would you agree? Hypothetically, if you were choosing to use a video to teach part of the unit we just discussed, talk me through how you would find it. If you are planning to use one, just tell me how you found that one. Are you aware of any school policies regarding the use of videos? How about technology use in general	Ask for clarification of answer. Eg. - When would be the right time - Is there ever a time you could see it as appropriate - When would you not use one - Are some topics a better fit for videos? Prompt for - Colleagues - Google - YouTube - Subscriber service Would you be able to locate these policies? Could you tell me what the policies say?
Pedagogical knowledge	Research	Are you aware of any research about educational video design?	Where did you come into contact with it?

		How about any research about educational video use? (if not covered earlier) To your knowledge, does your school subscribe to any paid video services?	Flipped or blended classroom? Explain. Such as Click-View/EdRolo/Australian Maths Online/mathletics… (if they didn't mention earlier in searching for videos, why?)
Technological Knowledge TPACK	Technology 12	What technology exists in the school to help you show videos? Some teachers report frustrations with technology. Have you experienced this in relation to using videos? How would you rate the IT support you get when things go wrong? How consistent is your internet connection? Does this affect your planning? Some schools seem to be in love with technology, some fear it. Where would you put your school on this continuum? How about you personally, how would you rate your enthusiasm for educational technology? How about your skills in technology for teaching? How would you rate yourself?	IWB/Projectors/laptops Prompt for - Websites blocked for students or staff? YouTube, Facebook etc. - Slow/intermittent internet - Student behaviour - School policies regarding sharing videos? - Lack of hardware (mics, cameras etc.) Prompt for reasons Prompt for reasons Prompt for examples and video specific deliver methods etc.
	FOR CREATORS		
		Have you received any feedback from your school leadership about your videos? How about your colleagues, have they given you any feedback, positive or negative? Do you get time release or any other support to make them?	Have they watched them? Do they know about them? Do other teachers use your videos? Do you actively share them?

		What programs do you use to make them?	
Demographics		How long have you been teaching? How long at this school?	

Final Notes for interview 1:
If you find the time, would you be able to send me an e-mail whenever you decide to use an instructional video over the next three weeks? No more than two sentences explaining what you used it for and why would be awesome as well. Please don't change anything you would ordinarily do, just go about your job as you would normally.

Interview 2:

Following the classroom observation

Knowledge types	Theme	Questions	Probes
PCK Search practices/ Curriculum knowledge PCK	Selection	Considering a unit you have taught in the last few weeks, did you use any instructional videos? Take me back to when you were selecting this video. Talk me through that process. Prompt for not now, but back then What was the content or skill you aimed to teach with this video? Can we watch a little bit together? Talk me through the video from your perspective.	If none, why not? If some, choose one. - How did you locate this? (did you start with the skill/content to teach, did the video come first, did you think of the activity first?) - Did you learn anything from the video? - What search strategies or tools did you use? - Does it appear in the curriculum document? Are you likely to add it to the doc? - Would you choose a similar video for another group of students? (or is this one picked for these students in particular) - If you created it yourself, explain why you did that rather than choosing an existing one - Why these not others? What makes you reject a video? - Collect URL (Website address)

Content Knowledge		Did you check the accuracy of the video content?	- Discuss the design, and what the students will learn from the video If so, how? If not, why not? Prompt for - Time - Importance - Don’t know how
Pedagogical Knowledge/Knowledge of Learners	Differentiation	Did you show all of the students this video?	If not, why not? What did other students do?
PCK Technological Knowledge	Distribution and watching of video	Talk me through how the students watched the video you have described to me? Take me into the classroom. Can you talk me through this watching experience? Did the technology behave as you expected during the class?	Prompt for - Together on a projector - At home for homework - On their own laptop in class This might be as simple as – they sat down and watched the video then we discussed as a class. - Was there an intro? - Do you pause the videos - Do they pause the videos - Do the students complete a worksheet?
PCK/Knowledge of Learners	Reception/student perception	What was the student reception of the video like?	Did they like it, get bored? What was class behaviour like?
PCK	Effectiveness	How effective was the video in achieving the teaching aim you mentioned before? How did you measure this effectiveness?	Formally (test, quiz, activity) Informally (discussion etc.) Do you think some students learned more than others?

Knowledge of Learners/Curriculum knowledge/pedagogical knowledge Curriculum knowledge		What makes for a great video for students? When you think of great educational videos, do some come to mind? What would you like to see more of?	Prompt for - Audio - Colour - Length - Visual characteristics - Presenter Face - Content - Accuracy Any particular examples, producers, styles? If you could click your fingers and make a video or series of videos appear, what would it be?

Appendix F – Observation guide

The following pro-forma was used to record researcher observations during the nine classes observed. Actual observation notes ran to 5-8 pages per class. The codes indicate the elements of teaching noted.

Date:
Time/Period:
Purpose: To record the pedagogical actions of the participant while teaching using instructional videos
Annotated drawing of physical space

Participant:	Location:

Codes for observation: CM = Classroom Management; DI = Direct Instruction; ISI = Individual Student Interaction; MSI = Multiple Student Interaction; VI = Video Introduction/Instruction; G = Greeting; TS = Tech Support; AD = Administration; UT = Using Technology

Time	Observations	Observer Comments

Appendix G – Videos used by participants

The following table outlines the 58 videos participants reported using in classes. Readers are encouraged to search for the title on the appropriate platform to watch a particular video. Selected data referred to in the thesis is recorded for each video. Coding schemes for the original media, learner control, and video type are included following the table. Readers are encouraged to refer to the more detailed explanations of video types provided in Section 3.2.3 for further clarification.

Code	Video Name	Participant	Teacher Subject	Year level	Platform	Duration (min:sec)	Producer	Media	Type	Control
V1	Fiction Book Genres - What Is Fantasy	Alison	English	7	YouTube	5:23	Molding Minds	YTN	VS/AN	S
V2	How Does the Catholic Church Declare Official Saints?	Alison	Religious Education	8	YouTube	5:42	Busted Halo	YTN	AN	S
V3	Paige Hadley - #NeverGiveUp sacram	Alison	English	7	YouTube	4:28	SamsungAustralia	YTN	DOC	S
V4	Gruen: The Pitch: Abandon e-books	Alison	English	7	School system	2:44	ABC Australia	TV	AD	S
V5	Black Customer Racially Profiled In High End Store | What Would You Do? | WWYD	Alison	Religious Education	9	YouTube	9:06	ABC America	TV	DRA	S
V6	Guerrilla Marketing - Pay with a smile | Project Change	Carl	Business Studies	11	YouTube	2:16	Creative Guerilla Marketing	YTN	AD	S
V7	Gamechangers: Uber Case Study	Carl	Business Studies	12	YouTube	1:48	Peter Fisk	YTN	AD	S
V8	Jing-Jin-Ji, A MEGALOPOLIS | China's Future MEGAPROJECTS: Part 1	Carl	Economics	12	YouTube	2:42	The Daily Conversation	YTN	AN	S
V9	Uber Business Model Innovation: What makes Uber so disruptive?	Carl	Business Studies	12	YouTube	3:48	Uber (re-uploaded by Startup Xpress)	YTN	AN	S
V10	Which Countries are TAKING OFF in AFRICA?	Carl	Economics	12	YouTube	9:34	Visual Politik	YTN	COM	S
V11	Why does Australia FEAR China?	Carl	Economics	12	YouTube	13:51	Visual Politik	YTN	COM	S

V12	Royal Australian Mint Tour	Carl	Economics	12	YouTube	3:45	ABC Behind the News	TV	DOC	S
V13	First World War: the story of a global conflict	Carl	History	11	Website	31:34	The Guardian	W	DOC	LC
V14	Malcolm Turnbull's final message as PM: Australians must be 'dumbstruck'	Carl	Business Studies	11	YouTube	20:32	ABC News	TV	LCR	S
V15	What is Public Relations? Video by Sketch-22 Illustrated Media	Carl	Business Studies	11	YouTube	2:28	Sketch 22 Illustrated Media	YTN	WB	S
V16	The Cold War: Crash Course US History	Dennis	History	11	YouTube	13:34	Crash Course	YTN	COM	S
V17	The French Revolution: Crash course World History	Dennis	History	12	YouTube	11:54	CrashCourse	YTN	COM	S
V18	People's Century Part 09: 1933 Master Race	Dennis	History	11	YouTube	53:39	BBC/PBS	TV	DOC	S
V19	A brief history of Israel	Dennis	History	11	YouTube	9:41	TRIP'OL'II Productions	DVD	DOC	S
V20	Reds	Dennis	History	11	ClickView	48:05	Turner Broadcasting/BBC	TV	DOC	S
V21	Science Lab Safety	Helen	Science	8	YouTube	15:23	Flinn Scientific	DVD	COM	S
V22	Don't Die Young: Lungs	Helen	Science	8	ClickView	31:45	BBC	TV	DOC	S
V23	Elements Organised: A Periodic Table	Helen	Science	10	YouTube	24:59	BBC (reuploaded by bbcluver)	TV	DOC	S
V24	Food and Digestion: Science Building Blocks	Helen	Science	8	ClickView	26:17	ClickView Originals	CV	DOC	LC
V25	Alkali metals in water	Helen	Science	10	YouTube	2:21	BBC (reuploaded by ironnica)	TV	LCR	S
V26	Brainiac Alkali Metals	Helen	Science	10	YouTube	3:16	SkyOne (reuploaded by scientist3030)	TV	LCR	S
V27	How to use a Fire Hose Reel	Helen	Science	8	YouTube	1:58	concept safety systems	YTN	LHT	S
V28	How to use a Fire Blanket	Helen	Science	8	YouTube	0:49	Fire & Rescue NSW	YTN	LHT	S
V29	Fire Extinguishers Training Video - AUSTRALIAN Version Preview - Safetycare Workplace Safety	Helen	Science	8	YouTube	2:11	Safetycare	DVD	LHT	S
V30	Lab Safety Rap (Teachers)	Helen	Science	8	YouTube	4:26	Lauren Mistretta	YTN	MA	S

V31	The Elements Book	Helen	Science	10	YouTube	3:35	Theodore Gray	YTN	MA	S
V32	How To Write A Scientific Report	Louise	Science	7	YouTube	6:15	HighSchoolScience101	YTN	AN	S
V33	The Nervous System, Part 1: Crash Course A&P #8	Louise	Science	9	YouTube	10:35	Crash Course	YTN	COM	S
V34	What's Matter? - Crash Course Kids #3.1	Louise	Science	7	YouTube	3:30	Crash Course Kids	YTN	COM	S
V35	The Great Picnic Mix Up: Crash Course Kids #19.1	Louise	Science	7	YouTube	4:10	Crash Course Kids	YTN	COM	S
V36	Earthquakes 101 | National Geographic	Louise	Science	9	YouTube	2:56	National Geographic	W	DOC	S
V37	Module video: The unit circle	Louise	Mathematics	7	Maths Pathway	2:18	Math Pathway	MP	NT	LC
V38	What Is Diffusion?	Louise	Science	9	YouTube	5:02	Jeremy LeCornu	YTN	WB	S
V39	23 Cool Sculptures You Won't Believe Actually Exist	Lucy	Art	7	YouTube	7:22	Believe That	YTN	COM	S
V40	How to make a wire tree	Lucy	Art	7	YouTube	7:17	papierdreams	YTN	LHT	S
V41	The Meaning of Appropriation in Art | Art Terms | LittleArtTalks	Lucy	Art	9	YouTube	2:36	Litte Art Talks	YTN	TH/VS	LC
V42	Sacraments 101: Baptism (why we baptize)	Margaret	Religious Education	8	YouTube	6:28	Busted Halo	YTN	COM	S
V43	Life Before Birth - In the Womb	Margaret	Religious Education	11	YouTube	102:34	Naked Science	YTN	DOC	S
V44	Studying William Blake in Context Dr. David Higgins	Margaret	Literature	12	YouTube	27:17	The Faculties	YTN	LC	S
V45	Read Scripture: Mark	Margaret	Religious Education	8	YouTube	9:31	The Bible Project	YTN	WB	S
V46	Ch. 0: If The World Were A Village	Melissa	Religious Education	10	YouTube	12:54	Unknown - uploaded by mrharrisonwldhist	?	AN	S
V47	Horrible Histories Frightful First World War: How World War I Began	Melissa	History	10	YouTube	2:25	CBBC (uploaded by ABC ME)	TV	COM	S
V48	The Body Of Emmett Till | 100 Photos | TIME	Melissa	History	10	YouTube	8:18	TIME	W	DOC	S
V49	Q&A Senate Powerbrokers	Melissa	Religious Education	10	ABC iView	47:50	ABC Australia	TV	ID	S

V50	Horrible Histories Song - World War 1 Cousins - CBBC	Melissa	History	10	YouTube	2:15	CBBC	TV	MA	S
V51	Gregory Stanton: The Eight Stages of Genocide	Melissa	History	10	YouTube	21:34	24hoursforDarfur	YTN	TH	S
V52	What Are Independent, Dependent And Controlled Variables?	Troy	Science	7	YouTube	3:15	HighSchoolScience101	YTN	AN	LC
V53	Earth's Orbit, Rotation, Seasons and Moon	Troy	Science	7	YouTube	4:16	HighSchoolScience101	YTN	AN	LC
V54	Continental Drift	Troy	Science	9	YouTube	11:56	Mike Sammartano	YTN	AN	S
V55	Gravity Compilation: Crash Course Kids	Troy	Science	7	YouTube	14:32	Crash Course Kids	YTN	COM	S
V56	Bill Nye: Magnetism	Troy	Science	7	Local Files	23:01	Disney	TV	COM	S
V57	Different Forms Of Energy | Physics	Troy	Science	8	YouTube	14:27	Manocha Academy	YTN	LC	S
V58	Heart Dissection	Troy	Science	7	YouTube	7:59	HighSchoolScience101	YTN	LHT	LC

Media codes:

YTN	YouTube Native
TV	Television
W	Website
MP	Maths Pathway
CV	ClickView Original
DVD	Commercial DVD
?	Unknown

Control codes:

S	Class Projector Screen
LC	Learner controlled

Video Type codes

LC	Lecture capture	COM	Infotainment Combined
SC	Screencast	DRA	Dramatisation
VS	Voice over slides	AD	Advertisement
NT	Narrated Tablet (Khan Style)	MA	Memory Aid
AN	Animated declarative	LCR	Live Capture
LHT	Live action how-to	TH	Talking Head
WB	Whiteboard animation	ID	Interview/Dialogue
DOC	Documentary style		